- dissolved metals / metalloids including aluminium (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), boron (B), bromide (Br), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se), strontium (Sr), uranium (U), vanadium (V) and zinc (Zn).

Criteria, performance indicators and triggers for further actions would be documented in the *Groundwater Management Plan* for the Proposal.

4.7 TERRESTRIAL ECOLOGY

4.7.1 Introduction

The Director-General's Requirements (DGRs) issued by DP&I identified "***Biodiversity*** – *as a key issue for assessment including:*

- *measures taken to avoid, reduce or mitigate impacts on biodiversity;*
- *accurate estimates of proposed vegetation clearing;*
- *a detailed assessment of potential impacts of the development on any:*
  - *terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems; and*
  - *regionally significant remnant vegetation, or vegetation corridors; and*
  - *a comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term."*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Office of Environment and Heritage (OEH) which requested that biodiversity impacts be assessed using either the BioBanking Assessment Methodology or a detailed biodiversity assessment. OEH also made specific reference to the need for detailed survey and assessment of the Pink-tailed Worm-lizard, a threatened reptile species known from the location, and requested that assessment of the significance of direct and indirect impacts of the proposal be undertaken for threatened biodiversity known or considered likely to occur.

Further matters for consideration were provided by the Central West CMA who identified that "*the EIS should include identification of any Endangered Ecological Communities (EEC) vegetation and outline a Biodiversity Offset Strategy to compensate for the destruction of any mature trees with habitat values such as hollows"*, DRE who requested that "*the flora, fauna and ecological attributes of the disturbed area should be recorded and placed in a regional context*" and NOW who requested the EIS "*identify any impacts on groundwater dependent ecosystems*".

Following determination of the Proposal as a Controlled Action (in accordance with the EPBC Act), Additionally, the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) issued assessment requirements to the DP&I, to allow for bi-lateral assessment of the Proposal under the NSW State Significant Development assessment process. Supplementary DGRs issued by DP&I on 3 March 2012 included the assessment requirements of DSEWPaC, the most relevant of which was for the assessment of "*impacts on threatened species and ecological communities listed under Sections 18 and 184 of the Environment Protection and Biodiversity Conservation Act 1999*".

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to terrestrial ecology and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Loss of biodiversity and alteration to existing habitat (high).
- Direct adverse impact on threatened species, populations and communities (high).
- Local or regional reduction in distribution of threatened species, populations and endangered ecological communities (high).
- Reduced biodiversity value of the site (medium).
- Reduced local distribution of threatened species, populations and endangered ecological communities (medium).
- Detrimental health impacts on native fauna from ingestion of contaminated water (high).
- Injury or death of fauna from vehicle incidents (high).

The Terrestrial Ecology Assessment for the Proposal was undertaken by Mr Phillip Cameron and Ms Heidi Kolkert of OzArk Environment and Heritage Management Pty Limited (OzArk). Input and technical assistance was also provided by Dr Gilbert Whyte of Ecobiological and Dr Arthur White of Biosphere Environmental Consultants Pty Ltd ("BEC"). The resulting report is presented as Part 6 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as "OzArk (2013a)". The terrestrial ecology assessment of OzArk (2013a) was undertaken in accordance with the following guidelines.

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft* (DECC, 2004).
- *Draft Guidelines for Threatened Species Assessment* (DECC and DPI, 2005).
- *BioBanking Assessment Methodology (BBAM)* and *Credit Calculator Operational Manual* (DECC, 2008).
- *Threatened Species Assessment Guidelines: the Assessment of Significance* (DECC, 2007).
- *EPBC Act Policy Statement 1.1 Significant Impact Guidelines Matters of National Environmental Significance, May 2006* (DEWHA, 2006).

This subsection of the EIS provides a summary of the terrestrial ecology assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**.

4.7.2 Regional Setting

4.7.2.1 Central West Catchment

The DZP Site is located within the NSW Central West Catchment which comprises the Castlereagh, Bogan and Macquarie River valleys and covers approximately 92 000km^2. A wide diversity of landforms, vegetation species and communities occur within this catchment which is associated with two bioregions, namely:

- South-western Slopes Bioregion; and
- Brigalow Belt South Bioregion.

As a consequence of the confluence of the eastern and western influences, the Central West Catchment has a high level of biodiversity. At the time of European settlement, the catchment supported a complex mosaic of forests, temperate and semi-arid woodlands, wetlands, shrub lands, heaths and grasslands. Clearing and subsequent degradation have reduced this natural vegetation cover to a large number of small, isolated remnants on the less fertile and productive soils. For example, the Box and Ironbark woodlands which originally occupied large parts of the slopes and plains have been reduced by as much as 90%, and are now among the most significantly altered plant communities in NSW.

The Central West Catchment covers a wide diversity of landforms and vegetation, with more than 550 vertebrate species recorded in the catchment, 81 broad vegetation types (DEC, 2006) and 3 183 species of plants (CW CMA, 2013). There are 50 threatened flora species (22 endangered, 27 vulnerable and one species considered extinct) and 73 threatened fauna species (15 endangered and 58 vulnerable) listed in the schedules of the *Threatened Species Conservation Act 1995* (TSC Act) recorded in the Catchment or bioregion. Of these, five flora species (*Lepidium hysopifolium, Eucalyptus canobolensis, Zieria ingramii, Zieria obcordata* and *Rulingia procumbens*) and one fauna species (Purple Copper Butterfly – *Paralucia spinifera*) are considered endemic to the catchment. Of the remainder, many species would rely on retention, protection and enhancement of remaining woodland remnants, grasslands and wetlands.

The Central West CMA estimates that approximately 38% of the catchment is currently vegetated to some extent and 62% has been cleared (CW CMA, 2013).

4.7.2.2 Local Setting

The setting within which the Application Area is located has been highly cleared for agriculture with remnants of native vegetation largely restricted to the riparian corridors of the Macquarie River and tributaries, elevated hill tops and ridges and within road easements. OzArk (2013a) describes the local setting as supporting a mosaic of Box Gum Woodland, Fuzzy Box Woodland, Inland Grey Box Woodland, derived native grasslands and cleared / cropped land.

A review of the broad vegetation types of the Central West CMA mapped by *Reconstructed and Extant Distribution Native Vegetation in the Central West Catchment* (DEC, 2006) by OzArk (2013a) identified the following as occurring on and surrounding the proposed areas of disturbance (refer to *Figure 8* of OzArk, 2013a).

- Blakely's Red Gum – Yellow Box open woodland of the tablelands.
- Dry Woodland on rocky hills.
- Fuzzy Box woodland on flats and alluvial terraces.
- Inland Grey Box woodland.
- Mugga Ironbark – Box – White Cypress Pine woodland.
- River Red Gum riparian woodland/forest on floodplains.
- Tumbledown Red Gum – Black Cypress Pine – Red Box low woodland on hills.
- White Box – Kurrajong woodland.
- White Box – White Cypress Pine woodland.
- White Box woodland with a shrubby understorey.
- White Cypress Pine – Poplar Box – Bulloak woodland on footslopes and plains.
- Yellow Box woodland on flats and alluvial terraces of the slopes.

This diversity of vegetation communities is indicative of the varied landforms of the local setting, from alluvial flats and floodplains of the Macquarie River and tributaries through undulating plains and footslopes to steeper slopes, hills and ridges.

Dowds Hill, located on and to the east of the DZP Site, is one of the largest privately owned native vegetation remnants in the Central West CMA (approximately 800ha). While it is effectively an 'island' remnant within an agricultural landscape, some connectivity to smaller remnants of woodland is provided along fence lines, creek lines, roads and tree clumps to the Macquarie River.

Derived native grasslands, grazing country with scattered trees and tree clumps is the main vegetation community to be affected by the activity.

4.7.3 Assessment Methodology

4.7.3.1 Desktop Survey

Prior to the commencement of field survey, and again prior to completion, OzArk (2013a) reviewed various databases and previous investigations within the local and regional setting to gain an understanding of the biota that could be expected to occur within the DZP Site and associated areas of disturbance.

Table 4.52 identifies each of the database searches completed, the date of search and an overview of results.

Table 4.52
Biological Database Searches

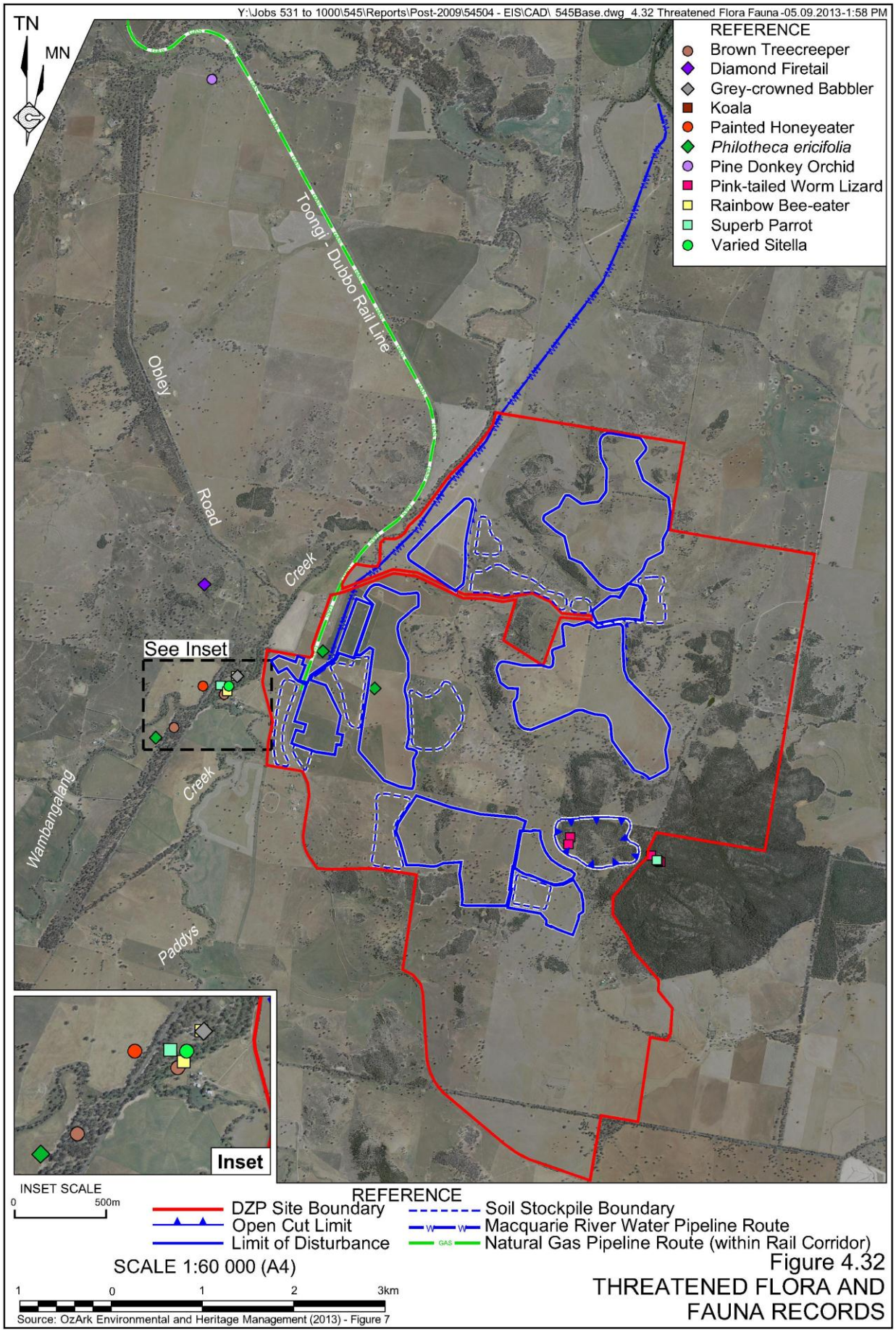
Database	Area searched (Date)	Results
NSW Government Wildlife Atlas	Central West - Talbragar Valley CMA (27 July 2012) Central West - Upper Slopes CMA (5 September 2012)	45 species within the Talbragar Valley subregion. 111 species within the Upper Slopes subregion. 4 threatened species identified within 10km of the Application Area.
Office of Environment and Heritage (OEH) Threatened Species online database	Central West (Upper Slopes) (22 August 2012)	104 species, populations or communities predicted or known to occur. Includes 52 species of threatened fauna, 10 species of threatened flora and 3 endangered ecological communities (EEC).
	Central West (Talbragar Valley) (30 August 2012)	94 items predicted or known to occur. Includes 48 species of threatened fauna, 10 species of threatened flora and 3 EECs.
DSEWPaC Register of Critical Habitat	Register of Critical Habitat (22 August 2012)	No habitats listed as 'Critical' are within the Application Area.
Office of Environment and Heritage – Critical Habitat Register	NSW Critical Habitat Register (22 August 2012)	No habitats listed as 'Critical' are within the Application Area.
Important Bird Areas (IBA)	Application Area (31 August 2012)	No IBA are located within the Application Area.
DSEWPaC Protected Matters (EPBC Act) Database	Dubbo LGA (31 August 2012)	5 Threatened Ecological Communities 23 Threatened Species 17 Migratory Species 17 Listed Marine Species
Atlas of Living Australia	5km radius centred on the Open Cut (31 August 2012)	9 threatened fauna species 2 threatened flora species.
NSW Department of Primary Industries – Fishing and Aquaculture Threatened and Protected Species Records Viewer	Dubbo LGA (31 August 2012)	Freshwater Catfish, Murray Cod and Trout Cod have been previously recorded in the Dubbo LGA.
Source: Modified after OzArk (2013a) – Table 3		

A full summary of the results of these searches is provided by *Appendices 1 and 2* of OzArk (2013a).

Based on the database searches, **Figure 4.32** provides a summary of the threatened flora and fauna identified on or immediately surrounding the DZP Site.

Records from the following field surveys completed locally were also reviewed by OzArk (2013a).

- Flora Study of the proposed Dubbo Zirconia Project, at Toongi via Dubbo, NSW, April 2002 (GCNRC 2002a).
- Flora Study of the proposed Dubbo Zirconia Project Railway Reserve Toongi, via Dubbo, May 2002 (GCNRC 2002b).
- Flora Study of the Proposed Dubbo Zirconia Project Toongi, via Dubbo. Proposed Water Pipeline Route, May 2002 (GCNRC 2002c).
- Vertebrate Fauna Study and Impact Assessment of the Proposed Dubbo Zirconia Project Area, at Toongi via Dubbo, NSW, April 2002 (Goldney, 2002).


Y:\Jobs 531 to 1000\545\Reports\Post-2009\54504 - EIS\CAD\ 545Base.dwg 4.32 Threatened Flora Fauna -05.09.2013-1:58 PM
TN
MN
REFERENCE
Brown Treecreeper
Diamond Firetail
Grey-crowned Babbler
Koala
Painted Honeyeater
Philotheca ericifolia
Pine Donkey Orchid
Pink-tailed Worm Lizard
Rainbow Bee-eater
Superb Parrot
Varied Sitella
Toongi - Dubbo Rail Line
Obley
Road
Creek
See Inset
Wambangalang
Creek
Paddys
Inset
INSET SCALE
0
500m
REFERENCE
DZP Site Boundary
Open Cut Limit
Limit of Disturbance
Soil Stockpile Boundary
Macquarie River Water Pipeline Route
Natural Gas Pipeline Route (within Rail Corridor)
SCALE 1:60 000 (A4)
1
0
1
2
3km
Source: OzArk Environmental and Heritage Management (2013) - Figure 7
Figure 4.32
THREATENED FLORA AND FAUNA RECORDS

The flora surveys of GCNRC (2002a, b, c) identified seven distinct vegetation communities on the areas of the DZP Site surveyed and along the alignments of the Toongi-Dubbo Rail Line and Obley Road reserve. Included was a community satisfying the classification as Box-gum Woodland, listed as critically endangered under the EPBC Act and as endangered under the TSC Act. No threatened flora species or populations were recorded.

The fauna survey of Goldney (2002) identified:

- 115 species of bird, including 11 threatened species listed under the TSC Act and 2 under the EPBC Act;
- 31 species of mammal (20 native) including 3 threatened microchiropteran bats;
- 21 species of reptile;
- 10 species of amphibian; and
- 3 species of fish (in Wambangalang Creek).

In particular, Goldney (2002) recorded several Pink-tailed Worm-lizards, the first record of this species in the Dubbo LGA.

4.7.3.2 Field Survey

4.7.3.2.1 Introduction

Although the studies and records summarised in Section 4.7.3.1 provide a valuable database of threatened species records within the vicinity of the DZP Site, additional field surveys were completed by OzArk in order to add to the knowledge of threatened species, populations and communities that could be affected by the Proposal.

By considering the likelihood of occurrence of the various threatened biota, OzArk (2013a) was able to tailor field surveys to maximise the potential to observe these species should they occur on DZP Site, other component areas of the Proposal or surrounds.

4.7.3.2.2 The Study Areas

The area of assessment considered by OzArk (2013a) comprised four study areas, coinciding with the four component areas of the Proposal, namely:

- the DZP Site;
- Macquarie River Water Pipeline Corridor;
- Toongi-Dubbo Rail Line and Natural Gas Pipeline Corridor; and
- Obley Road (sections for realignment).

4.7.3.2.3 Flora Survey

DZP Site

Following from the flora survey of GCNRC (2002a), which included 35 sample sites where species composition and species abundance data was recorded, and 50m x 50m quadrats were examined to record the occurrence of all ground cover species present, OzArk (2013a) completed a further 24 (20m x 20m) quadrats, and 24 x 50m transects through the native vegetation. The quadrats and transects were assessed in accordance with the BioBanking Assessment Methodology (BBAM) (DECC, 2009). In addition, approximately 30 hours of Random Meanders (following Cropper, 1993) were completed.

OzArk (2013a) reports that due to the homogeneity of the vegetation types within the DZP Site, plots were extrapolated and modelled, where appropriate. Additional plot data undertaken by Geoff Cunningham in 2001 was used to indicate the quality of vegetation where plots were not undertaken in 2012. OzArk (2013a) also applied Biometric benchmark data in areas where plots were not undertaken leading to conservative assessments of vegetation quality, i.e. the quality of some vegetation is likely to be overestimated.

Figures 16 and *17* of OzArk (2013a) present the locations of the vegetation plots and transects over the DZP Site (of both GCNRC, 2002a, and OzArk, 2013a).

Toongi-Dubbo Rail Line

Following GCNRC (2002b), who completed 12 long transects covering the entire length (between Toongi and Dubbo) and selected 50m x 50m quadrats, OzArk (2013a) completed 27 additional spot checks using the Random Meander Technique (Cropper, 1993) to locate rare or threatened species identified as having been previously identified or likely to occur based on the desktop analysis documented in Section 4.7.3.1.

Macquarie River Water Pipeline

Following GCNRC (2002c), who used stereoscopic interpretation of colour aerial photos to identify vegetation community features and boundaries followed by 13 transects covering the entire length of the alignment of the pipeline at that time and selected 50m x 50m quadrats, OzArk (2013a) completed random meanders at selected locations to locate rare or threatened species identified as having been previously identified or likely to occur based on the desktop analysis documented in Section 4.7.3.1.

Obley Road

OzArk (2013a) drove the entire length of Obley Road from Newell Highway to Toongi Road to map vegetation communities. The nine noted locations for road realignment were inspected on foot and aligned to a Biometric vegetation community (in accordance with BBAM). Individual trees in the zone of realignment were inspected for potential threatened species habitat. Two vegetation quadrats (20m x 20m), and two 50m transects through native vegetation within the road reserve was undertaken as per BBAM. As for the surveys of the Macquarie River Water Pipeline and Toongi-Dubbo Rail Line, the purpose of the survey was to locate rare or threatened species identified as having been previously identified or likely to occur based on the desktop analysis documented in Section 4.7.3.1.

Plant Identification

Plant identification was made according to recent nomenclature in Harden 1990 to 2002, Cunningham *et al.* 1992, and the PlantNet NSW Flora Online of the Royal Botanic Gardens and Domain Trust (RBG, 2011). The national conservation significance of flora was determined by referencing *Rare or Threatened Australian Plants* (ROTAP) (Briggs and Leigh, 2006) and the Schedules associated with the TSC Act or the EPBC Act.

Vegetation Mapping

Vegetation communities recorded by GCNRC (2002a,b,c) were transcribed into communities of 'best fit' in accordance with the BBAM (DECC, 2009) and incorporated into the vegetation maps generated by OzArk (2013a).

To further improve the accuracy of vegetation mapping, OzArk (2013a) collected Rapid Data Points (RDPs)[3] across areas of intact vegetation in addition to plots collected in accordance with BBAM.

Targeted Surveys

OzArk (2013a) also undertook targeted surveys for the following flora groups.

- Terrestrial orchids. Undertaken during the relevant flowering periods, searches for two threatened orchids, Cobar Greenhood Orchid (*Pterostylis cobarensis*) (TSC and EPBC Acts) and Pine Donkey Orchid (*Diuris tricolor*) (TSC Act), were completed.
- Threatened (non-orchid) plant species. Searches for two species known to, or considered as likely to occur locally (*Philotheca ericifolia*, *Swainsona sp.*) were completed.
- Threatened Ecological Communities. Searches for five threatened ecological communities (TECs), considered as having the potential to occur locally, were completed. Assessment of the presence of any EEC was based on general reconnaissance of the Application Area, together with examination of detailed floristic plot survey as detailed above. Comparisons of delineated vegetation communities were made against species lists and descriptions provided in the relevant Final Determinations.

A more detailed description of the flora survey effort is provided by OzArk (2013a – *Section 4.5*).

[3] Refer to *Section 4.6.2.6* of OzArk 2013 for further description on the application of the RDP methodology.

4.7.3.2.4 Fauna Surveys

Following from Goldney (2002), OzArk completed various surveys of the DZP Site, Macquarie River Water Pipeline, Toongi-Dubbo Rail Line and Obley Road between February 2012 and May 2013. A complete record of the survey methods implemented is provided in *Sections 4.5.1* to *4.5.10* (and *Table 5*) of OzArk (2013a) which is summarised as follows.

- Echolocation: to identify the possible presence of any microchiropterans (small bats) that may be present. Sites were selected where habitats likely to be used by microchiropterans during their foraging and dispersal periods (i.e. woodlands and habitat ecotones) or as roosting sites (i.e. hollow-bearing trees where present) were present.
- Elliot Trapping: using Type A and Type B traps for small ground dwelling animals were positioned in suitable areas within and outside the proposed areas of disturbance in an attempt to capture an overview of locally occurring fauna.
- Hair Tube / Hair Funnel Traps: were placed in each of the fauna habitats present, particularly the woodland portions of the locality. Hair funnels were set out at 10m spaced intervals with collected hairs analysed by a specialist in the field.
- Call Playback: followed the methods described by Kavanagh and Peake (1993) and Debus (1995) targeting the following threatened species: Koala (*Phascolarctos cinereus*); Bush Stone Curlew (*Burhinus grallarius*); Malleefowl (*Leipoa ocellata*); Powerful Owl (*Ninox strenua*); Masked Owl (*Tyto novaehollandiae*); and Barking Owl (*Ninox connivens*).
- Bird Survey (Diurnal and Nocturnal): was undertaken in all vegetation types with targeted bird watching was undertaken near any habitat trees to identify possible nesting or roosting areas. Birds were identified via visual observation and characteristic call. Any incidental observations or records made whilst traversing the site or conducting additional surveys were noted.
- Spotlighting: undertaken either on foot or by motor vehicle for sessions lasted from 60 to 120 minutes, with tracks, clearings and access ways being targeted.
- Scat and Tracks: all scats and raptor pellets encountered during the course of the field survey were collected and examined to determine species presence.
- Herpetofauna Survey (Nocturnal and Diurnal): consisting of hand searches for frogs and reptiles under rocks, logs, bark, ground debris and other debris around watercourses and dams were conducted at the same time as the bird surveys and opportunistically during all other activities within the Application Area. The habitat of the Application Area was assessed in terms of its suitability for threatened herpetofauna species.
- Aquatic habitat survey / frog survey: of watercourses, creeks and water bodies within the DZP Site were assessed for the potential to provide habitat for threatened frogs. Tadpoles that were caught were transferred to a clear plastic container, identified and returned to the site of capture. Dr Arthur White of Biosphere Environmental Consultants Pty Ltd (BEC) assisted for species

identification when on site. A survey for threatened fish and other aquatic ecology was conducted by AHA (2013) Part 7 of the *Specialist Consultant Studies Compendium*).

- Wetland and Migratory Bird Census: was undertaken over those areas of the Wambangalang Creek floodplain, Macquarie River Water Pipeline and Toongi-Dubbo Rail Line associated with the Macquarie River floodplain. The census included a meandering walk for visual observations and acoustic noting of bird calls.
- Opportunistic sightings (Platypus): known to occur in Wambangalang Creek and the Macquarie River, survey included a general assessment for likely habitat in potential platypus habitat areas and a survey of banks for burrow structures in the of areas of river bank which may be impacted by the installation of the water pipeline and any waterway crossings.
- Habitat Assessment: in which an assessment of the relative value of the habitat present within the various components of the Application Area was undertaken. This assessment focused primarily on the identification of specific habitat types and resources on the site favoured by known threatened species from the region. Where areas had a combination of key habitat elements which were more likely to provide an environment in which a threatened plant would be recorded, it was given closer inspection.
- Pink-tailed Worm-lizard: Specialist targeted assessment for *Aprasia parapulchella* was undertaken by herpetofauna expert Dr Arthur White (of BEC). Dr White has completed five field survey campaigns, assisted by OzArk or members of Dubbo Field Naturalist & Conservation Society for some, between March 2012 and May 2013. Surveys included overturning surface rocks in areas of likely habitat to expose resident lizard (or sloughed skin) which are generally found within ant nests. Dr White also completed a habitat assessment based on a habitat scoring scheme developed for the purpose of assessing a proposed offset strategy for the species to satisfy the EPBC Act Offset Policy of DSEWPaC (DSEWPaC, 2012).
- Other surveys completed relevant to the Pink-tailed Worm-lizard included the field survey and observations of Goldney (2002) and survey of specific habitat parameters including soil type, vegetation coverage, slope and ant species present completed by Dr Gilbert Whyte of Ecobiological (Kleinfelder, 2013)[4]. The specific methodologies and results of the surveys by BEC and Ecobiological are included in separate reports appended to OzArk (2013a).

Figures 13 to *15* of OzArk (2013a) provide the locations of the various fauna survey effort over the DZP Site.

[4] Provided as *Appendix A* of Pink-tailed Worm-lizard Plan Of Management (*Appendix 13* of OzArk, 2013a)

4.7.4 Identified Flora and Fauna

4.7.4.1 Flora

4.7.4.1.1 Vegetation Communities

DZP Site

While a large proportion of the DZP Site has been cleared, OzArk (2013a) identified that significant areas retain native groundcover species with other areas providing remnant native woodland formations, generally in associated with watercourses or land unsuitable for tilling. The dominant canopy species are Fuzzy box, Inland grey box, Tumbledown gum, Black cypress pine, White cypress pine, Bulloak, White box and Blakely's red gum, with groundcover of generally poor diversity and structural complexity and very low levels of natural recruitment.

Considering the description of vegetation communities for the central west catchment under BBAM, OzArk (2013a) mapped the following six native vegetation communities within the DZP Site (see **Figure 4.33**). The New South Wales Vegetation Classification & Assessment Database Project (NSWVCA) reference of Benson et al. (2006) is also included where relevant.

- CW112: Blakely's Red Gum – Yellow Box Grassy Woodland of NSW South West Slopes Bioregion (Benson 277).
- CW121: Bulloak – White Cypress Pine Woodland mainly in the NSW South West Slopes Bioregion (Benson 54).
- CW138: Fuzzy Box - Inland Grey Box on alluvial brown loam soils of the NSW South Western Slopes Bioregion and southern BBS Bioregion (Benson 201). This community is a component of the Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South bioregions EEC.
- CW143: Heathy Shrublands on rocky outcrops of the western slopes.
- CW212: White Box - Tumbledown Gum Woodland on fine-grained sediments on the Central NSW central western slopes (Benson 270).
- CW213: White Box - White Cypress Pine - Inland Grey Box Woodland on the western slopes of NSW (Benson 267). This community is a component of the White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland) EEC.

  OzArk (2013a) further categorised this vegetation community on the basis of species diversity, formation and land use as follows.

  – CW213 Quality Remnants: representing those areas with >50% native groundcover and / or possessing a native mid and upper stratum (and which have not been subject to cropping); or

  – CW213 Derived Grasslands: as described by Benson (1996) and representing those areas with >50% weeds and which have and continue to be subject to rotational cropping.

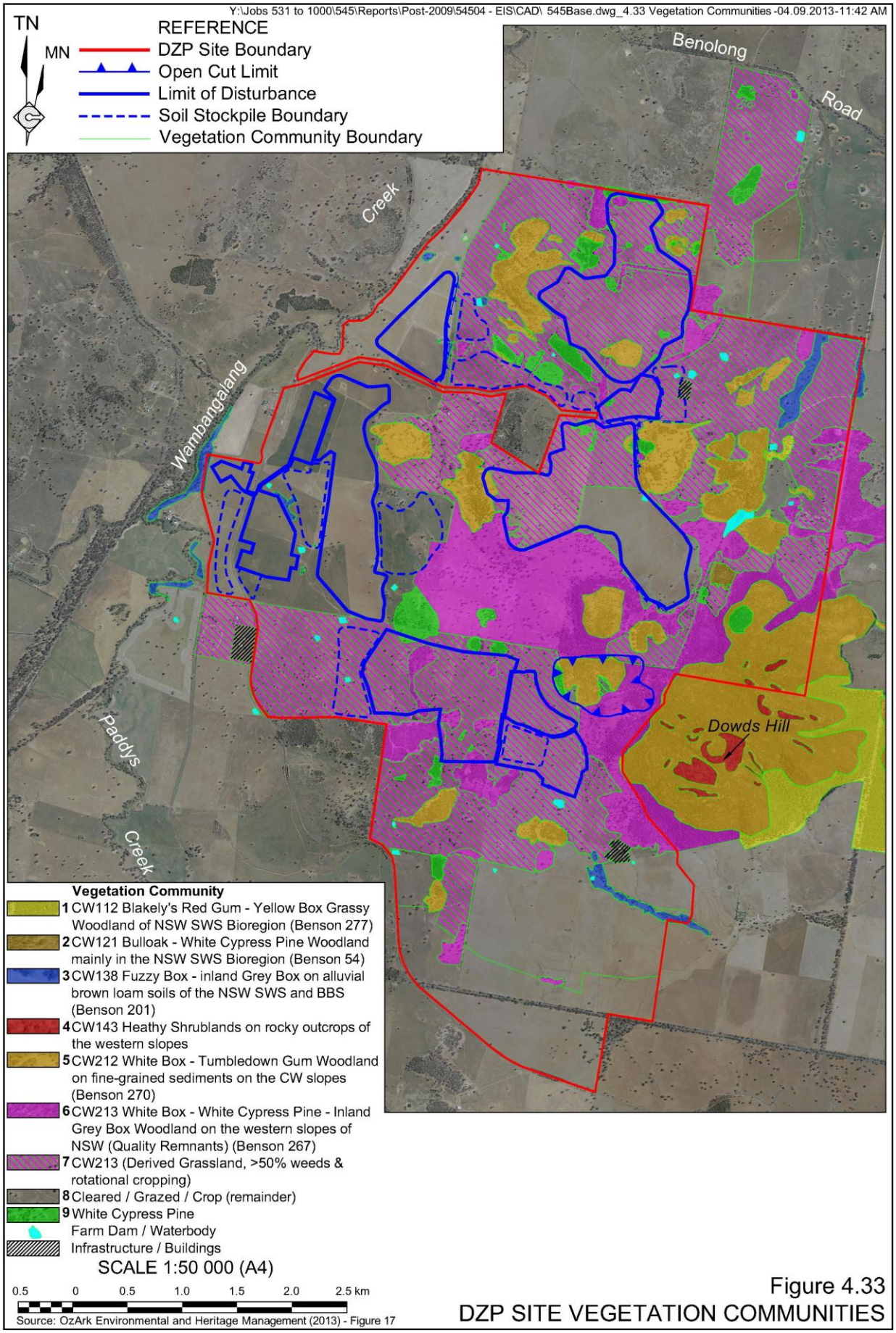


Figure 4.33
DZP SITE VEGETATION COMMUNITIES

Macquarie River Water Pipeline

OzArk (2013a) reports that the vegetation within the Macquarie River Water Pipeline easement is predominantly cropped and grazed paddocks. A BBAM equivalent community could not be correlated to the vegetation in the easement, however, tree clumps and scattered trees indicate that this area was once Fuzzy Box, Yellow Box, Inland Grey Box associated communities.

Toongi-Dubbo Rail Line

OzArk (2013a) reports that vegetation within the Obley Road reserve generally contains White Box, Yellow Box, Fuzzy Box Woodland or Inland Grey Box communities. Within those sections proposed for realignment, small areas of the following EECs were mapped.

- CW213: White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland).
- CW145: Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions.

4.7.4.1.2 Threatened Ecological Communities

DZP Site

Two TSC Act listed EECs have been mapped by OzArk (2013a) within the DZP Site.

- White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland) (CW213).
- Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South bioregions (CW138).

Two communities meeting the classification of EPBC Act listed TECs were recorded by Ozark (2013a) within the DZP Site.

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Critically Endangered Ecological Community (CEEC). The area of this community mapped occurs within the CW213 vegetation community and it is generally considered coincident with the Box-Gum Woodland EEC (under the TSC Act), although more stringent criteria apply to categorisation as a TEC under the EPBC Act.
- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia EEC. The area of this community mapped on the DZP Site also classifies as part of the CW213 vegetation community (as it is likely that White Box would have been a dominant part of the canopy at one stage).

Figure 4.34 presents the mapped locations of the TECs of the DZP Site.

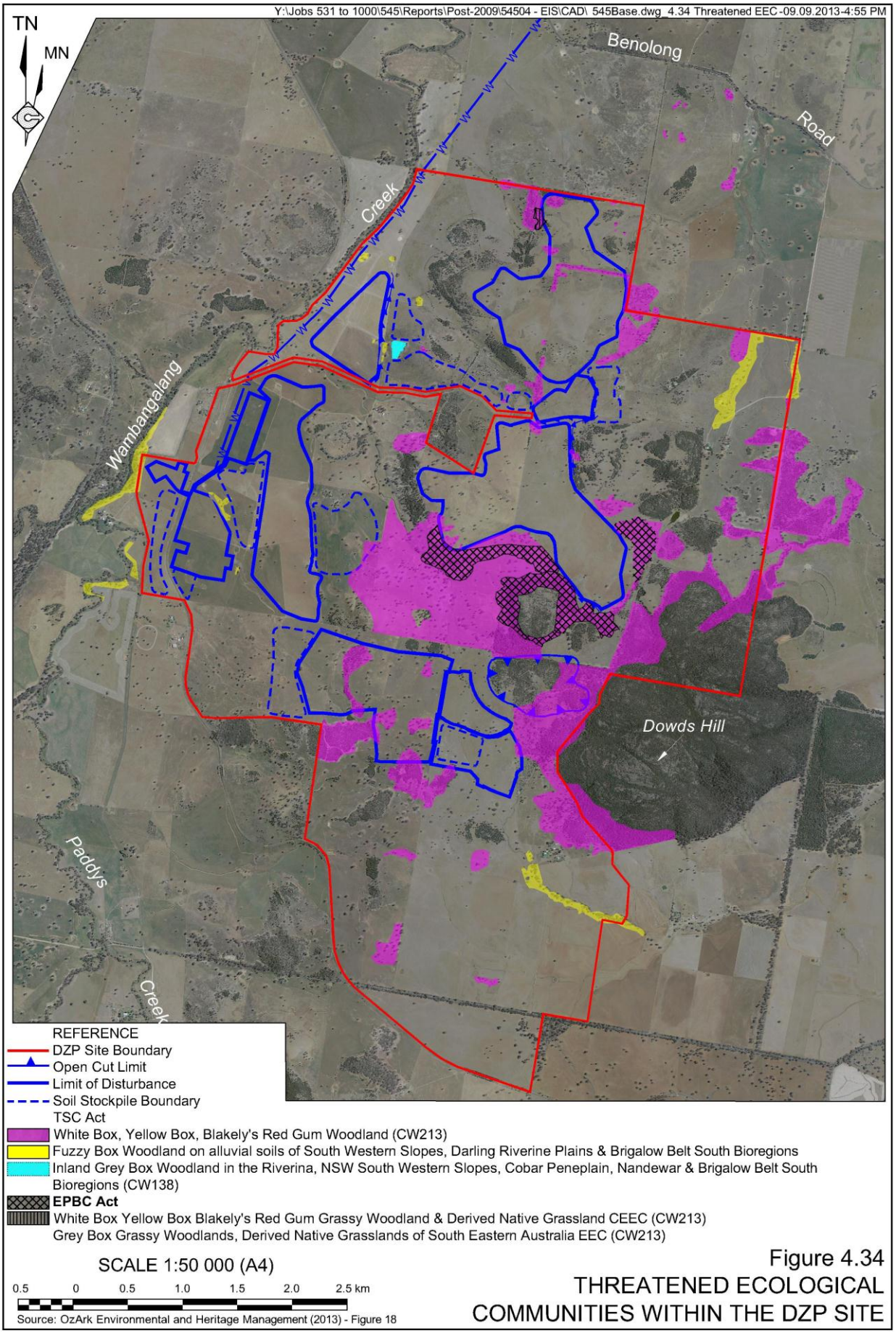


Figure 4.34
THREATENED ECOLOGICAL COMMUNITIES WITHIN THE DZP SITE

Obley Road Reserve

Along the alignment of Obley Road, two TSC Act listed EECs have also been identified by OzArk (2013a).

- White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland) (CW213).
- Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions (CW145).

No threatened ecological communities are present within the proposed Macquarie River Water Pipeline easement or Toongi-Dubbo Rail Line and Gas Pipeline Corridor.

4.7.4.1.3 Flora Species

A complete list of the flora identified within the DZP Site is provided by OzArk (2011a), a summary of which is as follows.

DZP Site

A total of 234 species of vascular flora were recorded by OzArk (2013a), including 67 (28%) introduced species. This reflects the effect of a long history of grazing and ploughing in some areas within the DZP Site.

No threatened species were recorded within the DZP Site by OzArk (2013a), although it is noted that *Philotheca ericifolia* was recorded on Dowds Hill adjacent to the DZP Site by GCNRC (2002a). There is also a previous recording of *Philotheca ericifolia* approximately 1km south of Toongi collected in 1964, however, this location which is now a cropped paddock. The locations of both records are outside the DZP Site and proposed impact footprint.

Seven species of protected orchid species (under Schedule 13 – *National Parks and Wildlife Act*) were also recorded within the DZP Site.

Toongi-Dubbo Rail Line

GCNRC (2002b) recorded 260 plant species within the corridor including 115 (44%) introduced species. These introduced species account for the bulk of the ground cover and biomass present.

No threatened plants were recorded by either GCNRC (2002b) or OzArk (2013a), however the protected plant species (under Schedule 13 – *National Parks and Wildlife Act*), *Diuris* sp. and *Microtis unifolia*, were recorded.

Macquarie River Water Pipeline

A total of 94 plant species were recorded, including 49 (52%) introduced species, by GCNRC (2002c). Additional species were not recorded by OzArk (2013a). OzArk (2013a) states that current disturbance precludes threatened species of flora from occurring.

Obley Road Reserve

Vegetation within the Obley Road reserve generally contains White Box, Yellow Box, Fuzzy Box Woodland or Inland Grey Box Communities that form part of the State and/or national listed ecological communities.

4.7.4.2 Fauna

4.7.4.2.1 Fauna Habitats

Habitat Types

Five main habitat types were identified that are likely to be altered (impacted or enhanced) by the Proposal. These are as follows.

- Woodlands: which can be further defined as:
  - semi-closed woodland associated with trachyte hills;
  - dense woodland associated with the slopes of Dowds Hill;
  - open grassy woodland on undulating slopes (mainly within vegetation community CW213); or
  - riparian woodland associated with waterways.
- Heath Scrub.
- Woodland/Grassland Ecotone.
- Wetland and Dam Habitat.
- Derived Grassland / Cleared Areas and Improved Pastures.

Each habitat type would provide different features and resource materials important to the survival of native fauna. Refer to *Section 5.5.1* of OzArk (2013a) for a full description of these features and resources and the species most likely to utilise these.

Koala Habitat

While the Dubbo LGA is listed not listed in Schedule 1 of SEPP 44, and as such SEPP 44 does not apply to the Proposal, there are previous records of Koalas within the Application Area. OzArk (2013a) have therefore used the framework of SEPP 44 to identify whether the Application Area as "potential koala habitat" based on the presence of ‘feed trees’ species. The Applicant Area is not considered “core koala habitat given the lack of recent Koala records or presence of a breeding population. Due to clearing on the alluvial flats, it is unlikely that koala movement would be facilitated from the riparian regions to the east across the Application Area. Thus it is only considered possible that sporadic transient Koalas may occur in the Application Area.

Habitat Corridors

Regionally, the Application Area is likely to provide corridors for the movement of native fauna along vegetated remnants, such as Obley Road, Toongi-Dubbo Rail Line and various creeks, and islands of habitat, such as Dowds Hill, for more mobile species.

The vegetation in the DZP Site provides connectivity with the Macquarie River and large areas of remnant native vegetation including Dowds Hill (adjacent to the open cut), Goobang National Park (30km southwest) and Momo State Forest (20km west) via connection to the remnant vegetation associated with Obley Road reserve, Wambangalang Creek. Obley Road, in particular, has a wide vegetated road reserve where Travelling Stock Routes were once located.

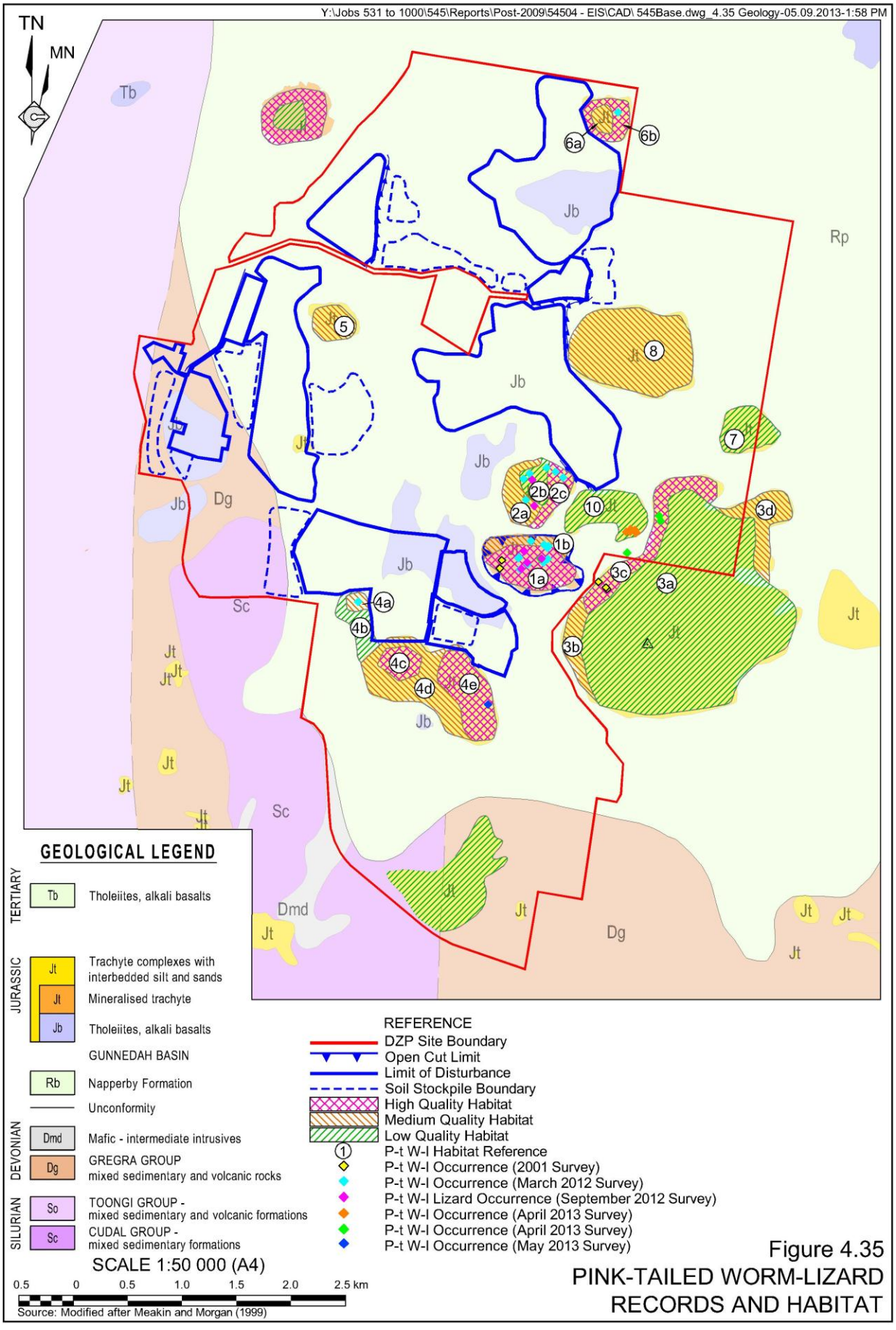
The levels of existing disturbance combined with the thin, linear nature of the remnants within and surrounding the DZP Site and wider Application Area reduce the potential value of these remnants as wildlife corridors for ground dwelling animals within the Critical Weight Range, namely those species with a body mass of between approximately 35g and 5.5kg that are most likely to be threatened or in decline.

Pink-tailed Worm-lizard Habitat

Following confirmation of the occurrence of the Pink-tailed Worm-lizard on the DZP Site, further research has been commissioned by the Applicant to identify potential Pink-tailed Worm-lizard habitat and determine what represents low, moderate and high quality habitat for the species. The factors contributing to the quality of habitat are considered in greater detail in a preliminary *Pink-tailed Worm-lizard Plan of Management* prepared by Biosphere Environmental Consultants Pty Ltd (refer to *Appendix 13* of OzArk, 2013a), however, can be summarised as follows.

- Pink-tailed Worm-lizard has strong associations with sloping, well drained, open landscapes characterised by outcroppings of lightly embedded surface rocks (Wong, 2011).
- Pink-tailed Worm-lizard prefers a grassy ground layer with little to no leaf litter, and relatively low tree and shrub cover (Osborne et al, 1991; Osborne and McKergow, 1993; Michael and Herring, 2005; Robertson and Heard, 2008).
- Pink-tailed Worm-lizard prefers grassland with a high diversity and abundance of native grasses (Osborne and McKergow, 1993; Jones, 1999; Osborne, 1991).
- Pink-tailed Worm-lizard has been identified almost exclusively below lightly embedded surface rocks which are believed to be important for thermoregulation (Jones, 1992) and occurrence of ant nests (on which it feeds, Web and Shine, 1994; Wong, 2011).
- The occurrence of Pink-tailed Worm-lizards appears to be correlated to the underlying geology with most occurrences on intermediate volcanics, some occurrences on basalt, and almost never on sedimentary rocks and never on alluvial soils.
- The diet of Pink-tailed Worm-lizard consists almost exclusively of ant broods (Web and Shine, 1994; Wong, 2011).

On the basis of these habitat indicators, a habitat scoring scheme was developed and the available habitat of the DZP Site mapped. **Figure 4.35** presents the mapped habitat of the Pink-tailed Worm-lizard over the DZP Site. Strong correlation between areas mapped as high and moderate habitat and recorded occurrences of Pink-tailed Worm-lizard suggest the habitat scoring scheme is accurate.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TN
MN
GEOLOGICAL LEGEND
TERTIARY
Tb Tholeiites, alkali basalts
JURASSIC
Jt Trachyte complexes with interbedded silt and sands
Jt Mineralised trachyte
Jb Tholeiites, alkali basalts
GUNNEDAH BASIN
Rb Napperby Formation
Unconformity
DEVONIAN
Dmd Mafic - intermediate intrusives
Dg GREGRA GROUP mixed sedimentary and volcanic rocks
SILURIAN
So TOONGI GROUP - mixed sedimentary and volcanic formations
Sc CUDAL GROUP - mixed sedimentary formations
REFERENCE
DZP Site Boundary
Open Cut Limit
Limit of Disturbance
Soil Stockpile Boundary
High Quality Habitat
Medium Quality Habitat
Low Quality Habitat
1 P-t W-l Habitat Reference
P-t W-l Occurrence (2001 Survey)
P-t W-l Occurrence (March 2012 Survey)
P-t W-l Lizard Occurrence (September 2012 Survey)
P-t W-l Occurrence (April 2013 Survey)
P-t W-l Occurrence (April 2013 Survey)
P-t W-l Occurrence (May 2013 Survey)
SCALE 1:50 000 (A4)
0.5 0 0.5 1.0 1.5 2.0 2.5 km
Source: Modified after Meakin and Morgan (1999)
Figure 4.35
PINK-TAILED WORM-LIZARD RECORDS AND HABITAT

4.7.4.2.2 Fauna Species

OzArk (2013a) records a total of 185 vertebrate fauna species (178 native and 7 introduced) within the Application Area comprising the following.

- 23 reptile species.
- 9 frog species.
- 117 bird species (115 native and two introduced).
- 36 mammal species (31 native and 5 introduced species).

OzArk (2013a – *Appendix 4*) provides a complete list of the fauna recorded.

4.7.4.2.3 Threatened Fauna

Table 4.53 provides a summary of the threatened fauna recorded on or adjacent to the Application Area by OzArk (2013a), Goldney (2002) or other sources (and registered on the NSW Wildlife Atlas (DECCW 2009b)). **Figure 4.36** presents the location of the recorded threatened species within the DZP Site.

Table 4.53
Biological Database Searches

Page 1 of 2

Species	Listing		Source		
	TSC Act	EPBC Act	OzArk (2013a)	Goldney (2002)	NSW Wildlife Atlas
Great Egret (*Ardea alba*)		Y	Y		
Superb Parrot (*Polytelis swainsonii*)	Y	Y	Y		
Pink-tailed Worm-lizard (*Aprasia parapulchella*)	Y	Y	Y		
Large-eared Pied Bat (*Chalinolobus dwyeri*)	Y	Y	Y		
Greater Long-eared Bat (*Nyctophilus timoriensis / corbeni*)	Y	Y	Y		
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	Y		Y		
Little Eagle (*Hieraaetus morphnoides*)	Y		Y	Y	
Flame Robin (*Petroica phoenicea*)	Y		Y	Y	
Eastern Bentwing Bat (*Miniopterus schreibersii orianae oceanensis*)	Y		Y		
Barking Owl *(Ninox connivens*)	Y		Y	Y	
Brown Tree-creeper (*Climacteris picumnus*)	Y		Y	Y	
Diamond Firetail (*Stagonopleura guttata*)	Y		Y	Y	
Glossy Black Cockatoo (*Calyptorhynchus lathami*)	Y		Y		
Grey-crowned Babbler (Pomatostomus temporalis temporalis)	Y		Y	Y	
Hooded Robin (*Melanodryas cucullata*)	Y		Y	Y	
Little Pied Bat (*Chalinolobus picatus*)	Y		Y		
Speckled Warbler (*Pyrrholaemus saggitatus*)	Y		Y	Y	
Yellow-bellied Sheathtail bat (*Saccolaimus flaviventris*)	Y		Y		
Swift Parrot (*Lathamus discolour*)	Y	Y		Y	

Table 4.53 (Cont'd)
Biological Database Searches

Species	Listing		Source		
	TSC Act	EPBC Act	OzArk (2013a)	Goldney (2002)	NSW Wildlife Atlas
Koala (*Phascolarctos cinereus*)	Y	Y		Y	
Spotted Harrier (*Circus assimilis*)	Y			Y	
Square-tailed Kite (*Lophoictinia isura*)	Y			Y	
Rainbow Bee-eater (*Merops ornatus*)		Y			Y
Black-chinned Honeyeater (*Melithreptus gularis gularis*)	Y				Y
Masked Owl (*Tyto novaehollandiae*)	Y				Y
Grey Falcon (*Falco hypoleucos*)	Y				Y
Painted Honeyeater (*Grantiella picta*)	Y				Y
Varied Sittella (*Daphoenositta chrysoptera*)	Y				Y
Source: Modified after OzArk (2013a) – Section 5.4.3					

Of greatest significance is the occurrence of the Pink-tailed Worm-lizard, not previously known from the Dubbo region. To date, 35 individual lizards have been identified within five of the habitat areas identified over the DZP Site (see **Figure 4.35**). As illustrated by **Figure 4.35**, with the exception of those individuals recorded within Habitat Area 1 over the open cut, the site layout has been designed/arranged to avoid impact on this species and areas of high quality habitat.

4.7.4.3 Subject Species and Communities

Subject species are those threatened species or communities identified on, or considered as having the potential to occur in the habitats present within the four study areas defined in Section 4.7.3.2.2 (DEC, 2004).

Based on the known records and predicted occurrences of threatened flora and fauna generated by these desktop studies, OzArk (2013a) considers the likelihood of each identified species or community to occur. Based on database or other records, presence or absence of suitable habitat, features of the defined study areas, results of the field survey (refer to Section 4.7.4) and professional judgement, the likelihood of occurrence was defined by OzArk (2013a) as follows.

- "Yes" = the species was or has been observed on the site.
- "Likely" = a medium to high probability that a species uses the site.
- "Potential" = suitable habitat for a species occurs on the site, but there is insufficient information to the species as likely to occur, or unlikely to occur.
- "Unlikely" = a very low to low probability that a species uses the site.
- "No" = habitat on-site and in the vicinity is unsuitable for the species.

Appendix 3 of OzArk (2013a) provides the detailed assessment of likelihood.

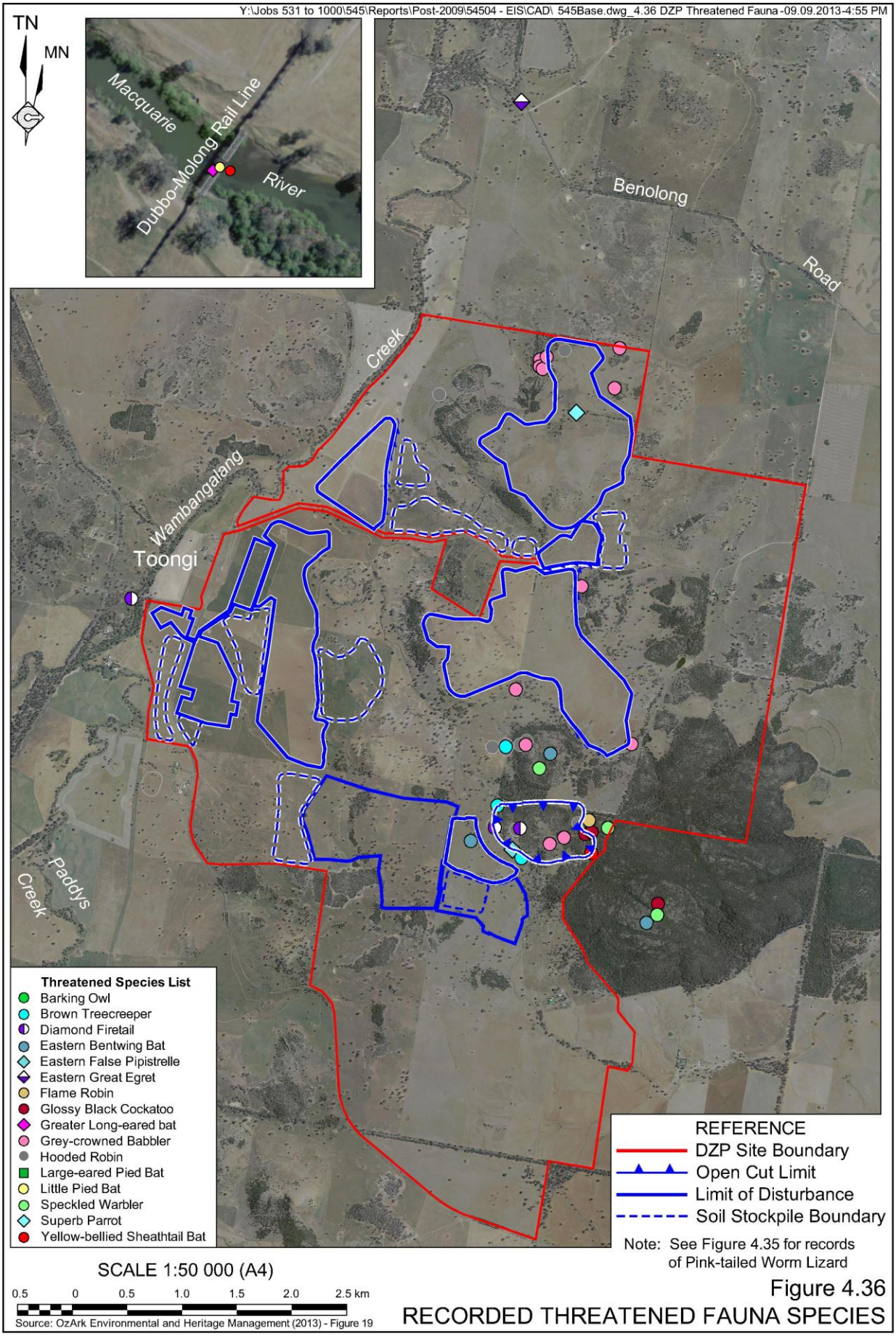


Figure 4.36
RECORDED THREATENED FAUNA SPECIES

Of an original list of 97 threatened species and communities either previously recorded or predicted to occur within the local setting, OzArk (2013a) have refined this list to 70 species and communities including:

- 5 (of an original list of 6) threatened ecological communities (all of which have been identified);
- 9 (of an original list of 20) threatened plant species; and
- 56 (of an original list of 71) threatened and/or migratory fauna species (including 22 known to occur, 6 likely to occur and 28 species that may occur).

The complete list of 70 species and communities, along with their status as recorded, likely to occur, potentially occurring or unlikely to occur, is provided by *Table 4* of OzArk (2013a).

4.7.5 Management and Mitigations Measures

4.7.5.1 Introduction

In line with Step 4 of the *Draft Guidelines for Threatened Species Assessment* (DECCW and DoP, 2005), the Applicant has designed the Proposal to minimise impacts on threatened species by avoiding, then mitigating and finally offsetting impacts. The following subsections present the design features, operational controls and management measures proposed to avoid, then minimise and then offset impacts on local flora and fauna.

Given the proposed direct impacts on the Pink-tailed Worm-lizard, specific impact avoidance and mitigation measures are presented in Sections 4.7.5.2.2 and 4.7.5.4.2. Section 4.7.5.4.3 presents additional mitigation measures specific to other threatened species which could be potentially impacted by the Proposal.

4.7.5.2 Avoidance of Impacts

4.7.5.2.1 Native Vegetation

The following impact avoidance measures have been adopted by the Applicant.

- The site of the proposed processing operations and related infrastructure has been located over land which has been cleared of most trees for cropping and grazing and has been regularly cultivated for many years, i.e. there is no remnant native vegetation.
- The areas targeted for the positioning of disturbance associated with the management of waste materials and residues generated by the mining and processing operations considered local landforms and vegetation with efforts made to exclude the following areas.
  - Threatened ecological communities listed under the EPBC and TSC Acts.
  - The remnant vegetation of Dowds Hill, identified by OzArk (2013a) as a regionally significant remnant.

- Larger and intact remnants of native woodland vegetation, in particular, those wooded hill tops to the north of the open cut and north of Dowds Hill.
- Major watercourses, several of which contain the Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South bioregions.

It is noted that in identifying preferred areas for disturbance, areas of higher quality agricultural land was also attempted to be avoided.

- All areas suitable for listing as EPBC Act listed White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC have been avoided through re-design of the Proposal. Furthermore, 61.8ha of this community would be protected in perpetuity within the Biodiversity Offset Area.
- The size and location of the LRSF was redesigned to reduce the impact on the TSC Act Listed NSW Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South bioregions EEC to 0.1ha (on the margin of the Processing Plant Area). It is likely that in final design of the LRSF, this 0.1ha would be avoided along with the remaining 21.9ha which would be protected in perpetuity within the proposed Biodiversity Offset Area.

4.7.5.2.2 Pink-tailed Worm-lizard

In order to avoid as many known records of the Pink-tailed Worm-lizard (see **Figure 4.35**), and minimise the potential for impacts on additional species, the Applicant undertook the following impact avoidance.

- The design of the SRSF was modified to avoid a known occurrence of the species on moderate quality habitat (Habitat Area 4a).
- Several of the proposed cells of the Salt Encapsulation Cells have been modified to avoid impact on high quality habitat associated with a known occurrence of the species (Habitat Area 4e).
- The design of LRSF Area 4 was modified to avoid the known recorded and high quality habitat of Habitat Area 6.
- Several proposed soil stockpile locations have been discounted due to encroachment of areas of high or moderate quality habitat (in particular Habitat Area 4).

Impact on high and moderate quality habitat over the open cut is unable to be avoided given this represents the location of the ore body. Section 4.7.5.4.2 provides for proposed mitigation measures to be implemented to reduce the impact of this disturbance. An additional small area (1.6ha) of medium quality habitat (of Habitat Area 4) could not be completely avoided due to the large areas required for these structures and objective to locate these away from remnant native vegetation wherever possible. The proposed offsetting of these residual impacts is discussed in Section 2.17.8 and assessed in Section 4.7.6.2.

4.7.5.3 Minimisation of Impacts

In addition to the impact avoidance measures noted in Section 4.7.5.2, the following impact minimisation would be implemented by the Applicant.

- Noting the largest area of impact would be associated with the LRSF, the Applicant has, at significant cost, continued to modify the processing operations to improve water efficiency. Through this process optimisation, the water required has been reduced by approximately 20% since the Planning Focus Meeting, in turn reducing the area required for the LRSF.
- Further reducing the areas required for the LRSF, the Applicant has committed to the construction of a reverse osmosis water recycling plant to further reduce the volume of liquid residue discharged to the LRSF. The process and water recycling optimisation has reduced the overall liquid residue generation by 50%, in turn reducing the area required for the LRSF.
- As the area required for the LRSF has been reduced, the Applicant targeted exclusion of those LRSF Areas located on more ecologically sensitive areas. In particular, LRSF Area 7 to be located on the "Ugothery" property to the north of Dowds Hill would have impacted on areas of two EECs, White Box - Yellow Box - Blakely's Red Gum Grassy Woodland EEC and Fuzzy Box Woodland EEC.
- Cell C of the SRSF has been modified to minimise the area of disturbance to the White Box - Yellow Box - Blakely's Red Gum Grassy Woodland EEC.
- Ancillary areas of disturbance such as soil stockpiles have also been modified to minimise impacts on EECs. No soil stockpile area is now located over areas mapped as EECs.

4.7.5.4 Mitigation of Impacts

4.7.5.4.1 Vegetation Clearing

In order to mitigate the unavoidable impacts resulting from vegetation clearing, the Applicant would implement the following design features, operational controls and management measures.

- Induct and train employees and contractors on environmental requirements and procedures.
- Only clear sufficient vegetation for the subsequent 12 months operation only.
- Ensure that all areas of proposed disturbance are clearly marked on the ground prior to the commencement of clearing campaigns to minimise the potential for over clearing of vegetation.
- Install appropriate erosion and sediment control measures prior to vegetation clearing activities.

- Directly transfer stripped soil materials onto rehabilitation areas where practicable to maximise the opportunity for retention of the natural seed stock, and thereby maximise the revegetation of the final landform with endemic species.
- Spray weeds, where appropriate, prior to the topsoil stripping activities to avoid their proliferation on stockpiles or in subsequently rehabilitated areas.
- Undertake a program of weed control prior to soil stripping activities and following re-vegetation to ensure native plants are not overgrown during their early periods of growth.
- Undertake vegetation clearing operations, where practicable, between April and September to limit adverse impacts on tree dependent avifauna and microchiropteran bats.
- Engage a suitably qualified ecology expert to undertake a pre-clearance study of all areas to be disturbed and to relocate any identified threatened fauna to suitable habitat.
- Undertake all clearing of trees in accordance with a *Vegetation Clearing Protocol* (VCP). The VCP would require clearing of mature trees to be undertaken as follows.
  - Check all trees for the presence of nesting or roosting fauna before felling or pushing then start tree removal immediately after visual inspection.
  - When a tree with hollows requires removal, the tree is to be gradually nudged at intermittent intervals so that any animal occupying a habitat tree has the chance of vacating the area after the initial disturbance period.
  - Avoid leaving trees on ground unmanaged for more than two weeks as these would quickly become habitat for hollow dependent species.
- Familiarise[5] staff undertaking pre-clearing assessments prior to the clearing campaign in order to:
  - ensure they understand the nature and extent of each stage clearing;
  - determine what habitats are to be affected, the species which could be effected and how to manage species that may be affected by the activity; and
  - orientate themselves with the location, nature and extent of unaffected habitat so that they would know the best locations to release relocated fauna.
- Salvage tree trunks, major limbs and, if practicable, minor branches for use in rehabilitation of the DZP Site or enhancement of the BOA. If material is stockpiled, signs would be erected noting the significance and importance of this material for future rehabilitation and habitat creation.
- Confine, where practicable, vehicular access to formed and marked roads and tracks.

[5] The best seasonal timing for staff familiarisation and clearing plan preparation would be in spring when breeding hollows / nests are easier to detect.

- Limit vehicle speeds within the DZP Site to limit the potential for vehicle trauma to wildlife.
- Following completion of clearing operations, fence, as appropriate, sections of the DZP Site not required for ongoing operations to limit access by non-authorised personnel.
- Revegetate the DZP Site as described in Section 2.17 and in accordance with a *Mining Operations Plan*, or equivalent *Rehabilitation Management Plan* required by DRE, to be prepared prior to the commencement of activities on the DZP Site.
- Ensure species used during rehabilitation operations are consistent with vegetation community types located within the vicinity of the area to be rehabilitated and are suitable for the proposed final landform and land use.
- Monitor all areas of progressive and final rehabilitation and undertake remedial action in the event that rehabilitation does not comply with the relevant completion criteria.
- Fully implement the proposed *Biodiversity Offset Strategy*.
- Prepare an *Integrated Land Management Plan* (ILMP) (incorporating measures for application, measurement and management of the specific activities to be implemented within the proposed BOA) in consultation with the relevant government agencies. OzArk (2013a) has prepared a template for the preparation of the ILMP, following the standard format presented in the *Guide to Establishing a Biodiversity Offset Area*. Presented as *Appendix 17* of OzArk (2013a), the ILMP template provides a detailed outline of the standard and additional management actions to be defined within the ILMP following approval of the proposed BOA (refer to Section 2.17.8.5).

4.7.5.4.2 Pink-tailed Worm-lizard Management

Despite the proposed impact avoidance measures proposed, the Proposal would still result in disturbance to 25.5ha of high quality and 9.8ha of medium quality habitat, primarily over the site of the open cut.

A *Pink-tailed Worm-lizard Plan of Management* has been prepared by Biosphere Environmental Consultants Pty Ltd (refer to OzArk, 2013a – *Appendix 13*) which documents the proposed mitigation and management measures to be implemented to reduce the residual impacts. These measures can be summarised as follows.

- Conservation, Enhancement and Management of Known High-Quality Potential Habitat Areas.

  In general, habitat areas to be created or enhanced would be on sites close to trachyte outcrops, where grass cover is extensive, where tree canopies are limited, where surface shelter rocks (or artificial shelter materials) are abundant, and where ant prey species are abundant.

The initial focus for habitat creation and enhancement would be between Habitat Areas 1, 2 and 3 (see **Figure 4.35**), an area that has the right lithology, meets most of the ideal habitat components (except that it lacks surface shelter rocks) and links two apparently isolated groups of Pink-tailed Worm-lizards (on Habitat Areas 1 and 3). Once established as linking habitat, it may serve as a corridor for any displaced Pink-tailed Worm-lizards seeking to move away from the open cut and Habitat Area 1 (whilst the western half of the open cut is developed) and investigate new habitat areas.

The *Pink-tailed Worm-lizard Plan of Management* provides further detail on:

– landscape surface preparation;

– collection and re-use of surface rocks; and

– use of artificial shelter materials (as surrogate surface rocks features when absent).

- Passive Relocation of Pink-tailed Worm-Lizards from the Eastern Half of the Open Cut.

  To enable the passive (unassisted) relocation of Pink-tailed Worm-lizards from the impact area to safe conservation areas, the open cut would be developed in two stages. The western half of the open cut would be developed first, allowing time for habitat corridors to become established leading from the eastern side of the open cut towards Dowds Hill (Habitat Area 3) to the east and Habitat Area 2 to the northwest. Development of the eastern side of the open cut would not commence for at least 10 years, providing time for any unassisted translocation to occur.

- Assisted Relocation of Pink-tailed Worm-Lizards from the Western Half of the Open Cut.

  In the twelve month period leading up to the commencement of open cut development, repeated searches of the area to be disturbed would be completed and any Pink-tailed Worm-lizards found collected, measured and relocated to established and conserved or new habitat areas created nearby. On identification, the rock that they were found under would also be relocated to the new habitat area (to discourage other Pink-tailed Worm-lizards to recolonise this site within the open cut impact area).

  Field searches and collection would not be attempted during summer or winter when the lizards are deeper underground and generally inaccessible.

- Monitoring and Reporting.

  Progress reports would be commissioned by AZL to follow each major survey and collection period, i.e. at the end of spring and the end of autumn. These reports would detail the areas surveyed, the animals collected and their relocation positions. It would also report on any modifications to the habitat areas that may be required.

An annual report would be prepared in June of each year to be submitted to both SEWPaC and OEH. This would contain the results of the two survey and collection periods for the year and recommend any changes to habitat modifications that may be required.

4.7.5.4.3 Other Threatened Species

Sandy creek and river banks in the Central West catchment are known breeding sites for the Rainbow bee-eater (Migratory EPBC Act). Given there would be some construction required within such habitats for bridge upgrades, the Applicant would implement the following mitigation measure.

- Plan all bridge upgrades outside the breeding period (between August to January).
- If this timing is not possible, inspect any creek bank to be affected for mouse size / snake sized horizontal holes in the expose incised creek bank.
- If suitable holes detected, commission an experienced ecologist to determine if Rainbow bee-eaters could be affected by the activity and manage them accordingly.

4.7.5.5 Offsetting of Impacts

In accordance with Step 4 of DEC and DPI (2005), the Applicant has proposed a Biodiversity Offset Area to offset the impact on biodiversity that cannot be avoided or mitigated. The primary objective when defining the area and composition of the BOA is to provide for at least a Tier 3 outcome as nominated by OEH (2011) (when the benefits of the BOA are compared to the impacts of the Proposal) and the minimum 90% direct offset benchmark of the EPBC Act Offsets Policy. Section 2.17.8, **Figure 2.23** and **Table 2.22** describe the proposed BOA and the implementation of an ILMP to define specific management activities to be implemented within the proposed BOA.

4.7.6 Assessment of Residual Impacts

4.7.6.1 Introduction

This subsection assesses the residual impacts of the Proposal on terrestrial ecology, and in particular considers the adequacy of the proposed BOS and residual impacts on threatened flora and fauna (in accordance with Step 3 of DEC and DPI, 2005). This step involves identifying not only the magnitude and duration of impacts, but also the significance of the impacts as related to the conservation importance of the habitat, individuals and populations likely to be affected.

4.7.6.2 Biodiversity Offset Strategy

4.7.6.2.1 NSW Offsets Policy (OEH, 2011)

OzArk (2013a) has used the BioBanking Assessment Methodology (BBAM) (DECCW, 2008), in accordance with the *NSW OEH Interim Policy on Assessing and Offsetting Biodiversity Impacts of Part 3A, State Significant Development (SSD) and State Significant Infrastructure (SSI) Projects* (OEH, 2011b) ("the OEH Interim Policy"), to quantify the nature and extent of offsets required for impacts within the Application Area (the BBAM 'Development Site') and provide within the proposed BOA (the BBAM 'BioBank Site').

Tables 2.21 and **2.22** of Section 2.17.8 provide the output generated by the BBAM credit calculator for the Development Site and BioBank Site.

The following reviews the matching of credits between the Development Site and BioBank Site considered against the Tier 1 ('Improve or Maintain'), Tier 2 ('No Net Loss') or Tier 3 ('Mitigated Net Loss') benchmarks.

Tier 1 'Improve or Maintain' Standard

Ecosystem Credits:

The proposed BOA does not achieve the "Improve or Maintain" as:

- Red flag[6] assets would be cleared, namely, CW112, CW213, CW138, CW121 and CW145; and
- The credits generated by the BioBank Site for CW213 do not meet those required based on the Development Site disturbance.

It is noted that a Tier 1 outcome for CW212 could be achieved given this is not a red flagged community and the BioBank Site provides a surplus of 2 619 credits. Unfortunately, the surplus credits are not an 'allowable type' to transfer to deficits in other affected communities.

Species Credits:

As noted in Section 2.17.8.4.3, OzArk (2013a) report that only the following raptor species do not meet the Tier 1 credit requirements (347 credit deficit).

- Grey Falcon.
- Little Eagle.
- Square-tailed Kite.

Notably, OzArk (2013a) identifies that a significant surplus of credits would be available for several species considered important due to their actual rarity within the region.

- *Aprasia parapulchella* (Pink-tailed Worm-lizard). The records identified on the DZP Site are the only known occurrence of the species in the Dubbo region. A surplus of 148 credits is provided by the proposed BOA.

[6] BBAM identified a Red Flag as an Endangered Ecological Community or a community with greater than 70% cleared within the affected catchment.

- *Philotheca ericifolia*. The recorded population of this species is within the proposed BOA. A surplus of 6 credits is provided by the proposed BOA.

Tier 2 'No Net Loss' Standard

'No Net Loss' is attained when a red flagged community is to be cleared but the credit requirements generated by the Development Site (disturbance area) are met or exceeded at the BioBank Site (proposed BOA). The following considers the three remaining impacted communities against the Tier 2 standard.

- CW138. A Tier 2 outcome is achieved for the CW138 community. A total of 17 ecosystem credits are generated by the Development Site and 238 credits are provided at the BioBank Site (a surplus of 221 surplus credits).

  Notably, the surplus credits may be allocated against CW213 as this is an allowable vegetation type.

- CW213. Even with the transfer of surplus credits from CW138 and CW112 (an 'allowable' vegetation type against CW213), a credit deficit of 1 765 remains (refer to *Section 8.3.9.4* of OzArk, 2013a) and a Tier 2 outcome is not achieved.

- CW145. None of this community is present within the proposed BOA and as such a credit deficit of 62 means that a Tier 2 outcome is not achieved.

Tier 3 'Mitigated Net Loss' outcome

Ecosystem credits

"Mitigated Net Loss" considers when a red flagged community is to be cleared and the ecosystem credits generated by the Development Site cannot be provided for by the BioBank Site. Notably, under Tier 3 assessment, offsetting is managed by replacing effected vegetation in hectares at a 2:1 ratio.

The two communities which do not meet a Tier 2 outcome are considered as follows.

- CW213 White Box - White Cypress Pine - Inland Grey Box woodland on the western slopes of NSW.
  - Based on a 2:1 ratio, 915.4ha are required for offsetting but only 613.3ha are available in the Biodiversity Offset Area (241 hectare deficit).
  - However, if the Quality Remnants and Derived Grasslands components of CW213 are considered separately, the following is demonstrated.
    - CW213 Quality Remnants require 87.4ha at 2:1 ratio. There are 306.5ha in the proposed BOA. This can be achieved directly as a Tier 3 outcome.
    - CW213 Derived Grasslands require 823.9ha at 2:1 ratio. There are 306.8ha of Derived Grasslands in the proposed BOA plus and 221.8ha of CW213 Quality Remnants not allocated. The total available (528.6ha) falls short of the 2:1 ratio and a Tier 3 outcome cannot be directly achieved. 'Variation of the offset rules for using ecosystem credits' have been applied.

- CW145 Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions.
  - Based on a 2:1 ratio, 2.16ha are required. This community does not occur within the proposed BOA and therefore a Tier 3 outcome cannot be directly achieved. 'Variation of the offset rules for using ecosystem credits' have been applied.

'Variation of the Offset Rules', as described in the OEH Interim Policy, provide a structured approach to determining how Proposals may, in lieu of meeting the 'improve or maintain standard', meet one of two alternative standards established under the interim policy. OzArk (2013a – *Sections 8.3.9.4 and 8.3.9.5*) considers the following variations.

- The proposed BOA generates significant surplus credits for locally and regionally important species.
- The CW213 Derived Grasslands may be considered as non-threatened given they are greater than 50% weedy and rotationally cropped. Furthermore, this vegetation type does not have the ability to improve under existing management regimes. The proposed 306.8ha of CW213 Derived Grasslands to be contained within the proposed BOA and improved, together with the surplus 221.8ha of CW213 Quality Remnants, is considered a more than adequate offset.
- Alternatively, the CW213 and CW145 deficit can be met by the proposed management of the local population of *Aprasia parapulchella (*Pink-tailed Worm-lizard) within the proposed BOA. This conservation outcome is consistent with the National Recovery Plan and Threat Abatement and Recovery criterion and the NSW OEH Priority Actions and Listed Activities to assist the Pink-tailed Worm-lizard.

<u>Species Credits</u>

Raptors were the only species that have species credit deficits, however, OzArk (2013a) report this as a common outcome of the BBAM, given these species all have very large home ranges (50km^2 to 100km^2) and can use a wide range of vegetation communities for feeding, breeding and roosting. 'Variation of the Offset Rules' are considered as follows.

- The ecosystem credits in the most productive habitats for these species would achieve a Tier 1 or Tier 2 outcome.
- The creation of a 1 021ha BOA would increase the habitat value of this land significantly by promoting the occurrence of favoured prey species (which would benefit the raptor species).

4.7.6.2.2 Evaluation against OEH Offset Principles

The following considers the adequacy of the proposed *Biodiversity Offset Strategy* against the 13 guiding "*Principles for the use of Biodiversity Offsets in NSW*" (DECC, 2008e).

- Principle 1: Impacts must be *avoided first* by using prevention and mitigation measures.

  Section 4.7.5.2 considers the impact avoidance measures incorporated into the design of the Proposal. In particular, areas of TECs and better quality remnant woodland vegetation were avoided where ever possible. Further modifications were made to the design of the site layout response to the identification of Pink-tailed Worm-lizard and mapping of higher quality habitat.

  Section 4.5.7.3 nominates the measures that would be implemented to further minimise the impact footprint of the Proposal and Section 4.7.5.4 nominates the measures that would be implemented to mitigate the residual impacts. These would include, amongst other measures and controls, implementation of vegetation clearing protocols to reduce the potential impact on threatened fauna species, progressive rehabilitation and the implementation of a *Pink-tailed Worm-lizard Plan of Management*.

- Principle 2: All regulatory requirements must be met.

  The Applicant would meet all regulatory requirements related to the construction, operation and rehabilitation of the Proposal.

- Principle 3: Offsets must never reward ongoing poor performance.

  The design of the DZP Site layout demonstrates the Applicant's ability to avoid and mitigate, as far as practicable, adverse impacts on biota (see Sections 4.5.7.2 to 4.5.7.4). In addition, the existing, voluntary environmental rehabilitation at the Peak Hill Gold Mine demonstrate the Applicant's willingness and capability to successfully complete rehabilitation of mine sites once mining operations have been completed.

  OzArk (2013a) provides further discussion on the environmental performance of Alkane Resources Ltd (of which AZL is a subsidiary) and its key personnel.

- Principle 4: Offsets will complement other government programs.

  The proposed BOA and implementation of a *Biodiversity Management Plan* would increase the biodiversity value of the DZP Site, conserve a regionally significant remnant within the Dubbo region, create corridors linking this remnant to other linear remnants in the landscape (Wambangalang Creek and Benolong Road), protect and enhance existing EECs, and address key threatening processes, all of which are in line with government programs.

- Principle 5: Offsets must be underpinned by sound ecological principles.

  The calculation of ecosystem credit requirements (based on the type and condition of vegetation to be disturbed) and an assessment of the value (in terms of ecosystem credits) provided by the proposed BOA has been completed in accordance with the BBAM and the OEH Interim Policy. Section 4.7.6.2.1 (and OzArk, 2013a) provides a detailed summary of the application of the BBAM to the assessment of the proposed BOA. It is noted that OzArk consulted regularly with OEH personnel (Dubbo Office) in the preparation of BioBanking Credit Statements and those presented in *Appendix 8* of OzArk (2013a) represent the results of several iterations following review and advice from OEH personnel.

- Principle 6: Offsets should aim to result in a net improvement in biodiversity over time.

  The area of vegetation protection, enhancement and conservation (approximately 1 021ha) is almost 2.1 times the area of native vegetation communities that would be disturbed by the proposal. If only considering the remnant native vegetation not subject to ongoing agricultural land use, i.e. excluding the Derived Grasslands component of CW213, this ratio increases to 14.4 times.

  It is largely on this basis that it is considered the proposed BOA meets either the Tier 1 (CW212), Tier 2 (CW138) or Tier 3 (CW145 and CW213) outcome in accordance with the OEH Interim Policy.

  The nominated species credits requirements would be achieved for all species except some raptors, however, as discussed in Section 4.7.6.2.1, the proposed BOA is likely to provide a net benefit to these species by encouraging the occurrence and viability of prey species.

- Principle 7: Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs.

  At this time, there is no arrangement for the establishment of inclusion of land in the conservation estate, or covenanting arrangements over the DZP Site. However, once acceptance of the BOA is obtained from the consent authority, the Applicant would implement an 'in perpetuity' conservation arrangement.

- Principle 8: Offsets should be agreed prior to the impact occurring.

  Approval of the BOA is expected as part of development consent for the Proposal[7]. As identified in the draft Statement of Commitments (Commitments 9.1 to 9.26), the Applicant would implement the native vegetation protection and enhancement measures of the BOA and prepare a *Biodiversity Management Plan* for monitoring and management of the offset areas within a nominated time frame.

[7] It is possible that approval may be in principle with exact form of the BOA to be confirmed and approved within a nominated timeframe in consultation with OEH and DP&I.

- Principle 9: Offsets must be quantifiable – the impacts and benefits must be reliably estimated.

  Figure 2.23 and **Table 2.21** quantify the total area of each vegetation community within the DZP Site and the areas of proposed disturbance. The condition of the vegetation to be disturbed has been classified and ecosystem credit requirements identified (using the BBAM) (see **Table 2.21**). The condition of each vegetation community to be incorporated into the proposed BOA has been identified, and ecosystem credits assigned to these on the basis of current community condition and proposed management (see **Table 2.22**).

- Principle 10: Offsets must be targeted – they must offset the impacts on a "like for like or better" basis.

  The ecosystem credits generated by the proposed BOA have been assessed using BBAM and on the basis of meeting the Tier 1, 2 or 3 outcomes of the OEH Interim Policy are considered as providing "like for like or better" vegetation.

  In particular, if only considering the vegetation not currently affected by ongoing agricultural use, "like for like" offsets achieve a Tier 2 or greater outcome for all but CW145 (of which only 1.08ha would be disturbed). The offset attributed to the CW213 Derived Grasslands include 221.8ha of CW213 Quality Remnants, considered "better" vegetation in this case.

- Principle 11: Offsets must be located appropriately.

  The proposed BOA occurs within and immediately surrounding the DZP Site and would include the same vegetation communities to those disturbed ("like for like or better" as required by Principle 10).

- Principle 12: Offsets must be supplementary.

  The proposed BOA is supplementary to proposed rehabilitation works on the DZP Site. Importantly, the proposed vegetation protection, enhancement and conservation are not already funded or have been funded or considered previously for funding.

- Principle 13: Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.

  The Applicant has committed to the proposed BOA and envisages this would be included as a condition of the development consent when granted. The Applicant's commitments to the BOA in Part 9 of the draft Statement of Commitments (Section 5) would form part of development consent. In addition, it is anticipated that the conditions to the development consent would include a requirement for the Applicant to undertake an independent compliance audit of the Proposal against the conditions of the development consent.

4.7.6.2.3 Commonwealth Environmental Offsets Policy

Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (the 'EPBC Offset Policy') was applied as potential impacts on the Pink-tailed Worm-lizard were considered to significant enough to warrant determination of the Proposal as a Controlled Action'. The EPBC Offsets Policy was followed to address its five key aims.

- To ensure the efficient, effective, timely, transparent, proportionate, scientifically robust and reasonable use of offsets under the EPBC Act.
- To provide greater certainty and guidance on how the offset was developed.
- To deliver improved environmental outcomes.
- To outline the appropriate nature and scale of offsets and how it was determined.
- To provide guidance on acceptable delivery mechanisms for offsets.

OzArk (2013a – *Section 8.4.7*) provides a detailed review of the various parameters and factors required to be considered and quantified in accordance with the DSEWPaC publication "*How to use the Offsets Assessment Guide*" (DSEWPaC, 2012). In summary, the proposed BOA would protect and manage in perpetuity for conservation:

- 82.3ha of high quality habitat (76.3% of all mapped high quality habitat);
- 114.7ha of medium quality habitat (64% of all mapped medium quality habitat); and
- 42ha of low quality habitat (11.43% of all mapped low quality habitat).

The identified habitat would be protected, conserved and enhanced (through the application of various management and mitigation measures described in the *Pink-tailed Worm-lizard Plan of Management*, OzArk, 2013a – *Appendix 13*). As previously reported in Section 2.17.8.4.3, the proposed BOA would provide for direct offsetting to the value of 158.6% of the proposed impact, well in excess of the benchmark 90% requirement of the EPBC Offsets Policy.

4.7.6.3 Clearing of Native Vegetation

Clearing native vegetation is the main ecological impact that would result from the Proposal, as it would lead to a reduction in available habitat for a number of threatened species which currently utilise the DZP Site.

Magnitude of Impact

Table 2.21 summarised the approximate areas of each vegetation community within the Application Area to be cleared. Notably, remnant native vegetation in moderate to good condition has been avoided as far as practicable with approximately 85% of the mapped vegetation communities (not considered cleared / grazing land) of the DZP Site to be cleared identified as Derived Grasslands and are >50% weedy and subject to rotational cropping.

Clearing of TECs would be limited to:

- 0.1ha of the TSC Act listed *Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South bioregions* on the DZP Site;
- 43.7ha of the TSC Act listed *White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland)* on the DZP Site; and
- 1.08ha of the *Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions* along Obley Road.

Impacts on the EPBC Act listed *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* CEEC and *Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia* EEC would be avoided.

Duration of Impact

The duration of the impacts is a consideration of the permanence and reversibility of impacts and considers both the resilience of the vegetation cleared and proposed mitigation measures proposed.

The affected communities are likely to be moderately to highly resilient as remnants of each remain in the local area, upon which genetic material would be drawn in the expansion of these communities within the final landform and conservation and amelioration areas. The resilience of each community would be increased given the proposed mitigation measures nominated in Section 4.7.5.4 which include management of weeds, feral pests and grazing, and general habitat enhancement activities.

Given the resilience of the vegetation communities affected, and the proposed revegetation and habitat enhancement included as part of the conservation and amelioration strategy, the impacts are considered to be reversible and are therefore temporary only.

Significance of Impacts

The significance of impacts consider both aspects related to the vegetation communities themselves, i.e. relative distribution, importance as habitat to threatened species, regional and local representation, as well as the mitigation and offset measures proposed.

The vegetation of the DZP Site to be cleared is typical of the vegetation found elsewhere in the region. Notably, clearing of EECs would be restricted to a combined area of 1.18ha from two separate EECs which would be offset through conservation and enhancement within the DZP Site. Section 4.7.6.2.1 provides an evaluation of the proposed BOA using BBAM. Critically, the proposed BOA has been assessed as meeting Tier 1, 2 or 3 (based on variations) outcomes for each of the impacted communities.

4.7.6.4 Impacts on Habitat Corridors

Existing cleared areas within the DZP Site are a significant barrier to connectivity and movement in the landscape. The cleared areas have been targeted for the construction of the LRSF, SRSF, SECs and WRE and as such the impacts on existing linkages via remnant native

vegetation would be minimised. Nine sections of Obley Road Reserve would be impacted as a result of road widening activities. The road reserve would not, however, be reduced in size nor connectivity severed. Thus, clearing of this habitat is unlikely affect a local fauna movement pathway or reduce. Connectivity is unlikely to be affected as a result of impact related to the construction of the Macquarie River Water Pipeline or Toongi-Dubbo Rail Line, as these easements are located within very disturbed and cleared environments.

In fact, through the establishment of the proposed BOA, the connectivity between local remnants is likely to improve with the remnant vegetation of Dowds Hill connected to that of Wambangalang Creek (a regional biodiversity link) and Benolong Road (a local biodiversity link). Furthermore, through the establishment of the proposed BOA and implementation of the *Pink-tailed Worm-lizard Plan of Management*, connectivity between current discrete areas of high quality Pink-tailed Worm-lizard habitat would be created. This would reduce the potential for one or more of these discrete sub-populations to become extinct as a result of events such as fire, agricultural disturbance, disturbance by feral animals (pigs) or other events.

4.7.6.5 Key Threatening Processes

The Proposal is likely to exacerbate the following key threatening processes listed under the TSC Act and EPBC Acts:

- Alteration to the natural flow regime of streams and their floodplains.
- Bush rock removal.
- Clearing of native vegetation.
- Loss of hollow-bearing trees.

OzArk (2013a) assess that the potential impacts on threatened species as a result of these key threatening processes would be minimised through implementing the environmental mitigation and management measures presented in Section 4.7.5.4, the establishment of the proposed BOA described in Section 2.17.8 and 4.7.5.5, and the implementation of the *Pink-tailed Worm-lizard Plan of Management* presented as *Appendix 13* of OzArk (2013a).

4.7.6.6 Critical Habitat

Critical habitat has not been declared under the TSC Act or EPBC Act for any species, population or community that occurs within the Application Area. Critical habitat has been broadly defined in the *National Recovery Plan* White Box-Yellow Box-Blakely's Red Gum Grassy Woodland ad Deriver Native Grassland (DECCW 2011b) as occurring on the moderate to highly fertile soils of the western slopes of NSW. The Application Area occurs within this region and consequently all remnant areas identified as Box-Gum Woodland EEC are considered critical habitat under the draft recovery plan.

Impacts on the Box-Gum Woodland have been limited to 43.7ha, with these impacts considered unavoidable and restricted to the smallest area possible. The Proposal would result in the rehabilitation of disturbed areas with species indicative of this community. Areas of critical habitat for Box-Gum Woodland are also included within proposed BOA (306.5ha), within these areas to be protected and enhanced.

4.7.6.7 Impacts on Threatened Species, Populations and Communities

4.7.6.7.1 Introduction

The following subsections consider the significance of impacts on those threatened species and communities identified on, considered likely to occur, or considered as having the potential to occur on the DZP Site or other impacted areas of the Application Area (refer to OzArk, 2013a – *Appendix 3*). The significance of the impacts has been assessed in accordance with the requirements of Section 5A of the EP&A Act and (where relevant) the *Significant Impact Guidelines 1.1* for Matters of NES under the EPBC Act by OzArk (2013a) based on:

- the importance of individual species, populations and/or plants and/or subpopulations that are likely to be affected by the Proposal in maintaining the long-term viability of the species, population or ecological community; and
- the importance of habitat features that are likely to be affected by the Proposal in maintaining the long-term viability of the species, population or ecological community.

A summary of the assessment for each species completed by OzArk (2013a) is provided in the following subsections. Where relevant, and based on reliance on similar habitat features, some species are grouped together. The complete assessment for each can be viewed as *Appendix 10* of OzArk (2013a).

4.7.6.7.2 Koala

Koalas are known to periodically occur around Dubbo, specifically along the Macquarie River. Koala scats were identified within the DZP Site in 2001, however, no signs of Koalas have been found during extensive survey in 2012. The previous record is considered to represent a sporadic record of a transient individual(s).

The vegetation of the DZP Site and Obley Road to be impacted is not considered as core habitat critical to the survival of these species. Furthermore, habitat would not become further fragmented or isolated and in fact the proposed BOA would likely improve habitat connectivity.

As a known locally occurring population of Koalas does not occur in the DZP Site or the Dubbo LGA, the Proposal is unlikely to cause impact to a locally occurring population of this species such that it is placed at risk of local extinction.

4.7.6.7.3 Superb Parrot, Swift Parrot and Regent Honeyeater

Both parrot species have been recorded feeding and perching on the DZP Site and the Regent Honeyeater is considered as having the potential to occur (refer to *Table 4* of OzArk, 2013a). Breeding habitat does not occur in the Dubbo LGA for any of these species, however, due to the abundance of Box-Gum Woodland and diverse habitats associated with Dowds Hill, the DZP Site is considered habitat for all three species during the non-breeding period. Clearing as a result of the Proposal is unlikely to affect the life cycle of the species such that a viable local population is likely to be placed at risk of extinction.

The Proposal would not result in further habitat fragmentation given the nomadic and opportunistic ecology of this species. Furthermore, the proposed BOA and rehabilitation of the DZP Site is likely to improve connectivity with isolated remnants in the DZP Site.

While the Proposal would reduce the extent of feeding resources within the DZP Site during initial clearing, resources suitable for these species would be increased and improved over time as a result of the proposed BOA and rehabilitation of the DZP Site. Furthermore, due to the nomadic and migratory nature of these species, such a small area of feeding habitat cannot be considered critical to their survival. The Proposal is therefore unlikely to cause impact to a locally occurring population of this species such that it is placed at risk of local extinction.

4.7.6.7.4 Flame Robin, Hooded Robin, Brown Tree-creeper, Varied Sittella, Speckled Warbler and Diamond Firetail

With the exception of the Varied Sittella, which is considered as having the potential to occur (refer to *Table 4* of OzArk, 2013a), all have been recorded within the DZP Site. On the basis of identification and presence of relevant habitat features (shrubby vegetation with tree hollows), OzArk (2013a) considers it likely that viable local populations of all six species occur on or immediately surrounding the DZP Site. The impact on shrubby vegetation would be limited to the open cut and based on the small area and presence of significant areas of this vegetation on Dowds Hill removal of this is unlikely to affect the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

Connectivity to large native remnants of suitable habitat in the locality is likely to be improved through the proposed BOA. Furthermore, rehabilitation and habitat enhancement of the proposed BOA would increase structural complexity, providing the shrubby habitat that is particularly important to these species.

It is possible that the Proposal would reduce the extent of feeding and breeding resources within the DZP Site on initial clearing, however, this is not considered likely to cause a significant impact on the local populations of these species. Over time, the availability of suitable habitat on the DZP Site and within the proposed BOA is likely to increase. These local populations are unlikely to be placed at risk of extinction due to the large amount of surrounding analogous habitat adjoining the DZP Site.

4.7.6.7.5 Black-chinned Honeyeater, Painted Honeyeater and Grey-crowned Babbler

The Grey-crowned Babbler is known to have feeding and breeding habitat associated with vegetation in the DZP Site. This species also frequents several of the homestead gardens across the DZP Site. This species is recorded in numerous locations throughout NSW and in fact, the Dubbo LGA is a stronghold for this species which is very common in the locality. The Black-chinned Honeyeater and Painted Honeyeater have not been recorded in the DZP Site, however, based on habitat parameters are considered as having the potential to utilise habitat in the DZP Site during some portion of their lifecycle (refer to *Table 4* of OzArk, 2013a). The habitat provided by the DZP is not considered critical to the survival of the species and therefore viable local populations of these species are unlikely to be placed at risk of extinction.

All three species have large feeding territories and are locally nomadic. Therefore relatively small areas of foraging, breeding and roosting habitats cannot be considered critical to the survival of the species in context with the broader landscape. Furthermore, it is unlikely that the Proposal would isolate and decrease the availability of quality habitat to the extent that the species is likely to decline.

Local populations of these species are unlikely to be placed at risk of extinction due to the large amount of surrounding analogous habitat adjoining the DZP Site and the mobile nature of these birds.

4.7.6.7.6 Little Eagle, Spotted Harrier, Square-tailed Kite and Grey Falcon

All have been recorded within the DZP Site. Due to the mobile nature of these species, hunting grounds in the DZP Site (open agricultural land) cannot be considered critical to the survival of this species, as open agricultural land within a similar woodland matrix is abundant in the locality. Breeding sites for these birds are more likely to occur in tall trees associated with riparian environments outside the DZP Site. Viable local populations of these species are unlikely to be placed at risk of extinction.

Some mature eucalypts (mainly isolated trees) would be removed, however, these are unlikely to be roost sites for these species (given more preferable roost sites exist outside the impact area). It is therefore unlikely that the Proposal would isolate and decrease the availability of quality habitat to the extent that the species is likely to decline.

It is unlikely that local populations would be placed at risk of extinction due to the large amount of analogous habitat adjoining the DZP Site.

4.7.6.7.7 Barking Owl and Masked Owl

Barking Owls have been identified within the DZP Site and Masked Owls are considered to have potential to occur in the DZP Site. Breeding hollows are known to occur on Wambangalang Creek and the Macquarie River, however, as no impact would occur to suitable riparian large hollow-bearing trees, the Proposal is unlikely to disrupt a local population of Barking Owls.

It is unlikely that local populations would be placed at risk of extinction due to the large amount of analogous habitat adjoining the DZP Site.

4.7.6.7.8 Glossy Black Cockatoo

Small families of Glossy Black Cockatoos were recorded daily on the DZP Site, and preferred feed species (*Allocasuarina sp*.) occur over the open cut and on land adjacent to Dowds Hill. The Glossy Black Cockatoo is dependent on large hollow-bearing eucalypts for nest sites. Due to the nomadic nature of this species, removal of feed trees and isolated hollow-bearing trees is unlikely to affect the life cycle of the species such that a viable local population is likely to be placed at risk of extinction.

The Proposal would not result in further habitat fragmentation given the nomadic and opportunistic ecology of this species. Furthermore, the proposed BOA and rehabilitation of the DZP Site is likely to improve connectivity with isolated remnants in the DZP Site.

It is possible that the Proposal would minimally reduce the extent of a feeding resource within the DZP Site. However, it is unlikely that a local population of the Glossy Black Cockatoos would be placed at risk of extinction due to the large amount of analogous habitat adjoining the DZP Site.

4.7.6.7.9 Greater Long-eared Bat, Eastern False Pipistrelle and Yellow-bellied Sheathtail bat

All three species, which generally roost in eucalypt hollows, but has also been found under loose bark on trees or in buildings, have been recorded on the DZP Site. Given the discrete nature of impacts predominantly on cleared agricultural land, viable local populations of these species are unlikely to be placed at risk of extinction.

The mobile nature of microchiropteran bats enables them to occupy foraging and roosting resources outside the DZP Site that are adequate for the species survival. As such, while it is possible that the Proposal would reduce the extent of feeding, roosting and/or breeding resources, a local population of either species being placed at risk of extinction is unlikely due to the large amount of surrounding analogous habitat adjoining the DZP Site

4.7.6.7.10 Large-eared Pied Bat, Eastern Bentwing Bat and Little Pied Bat

All three species were recorded within the DZP Site. Based on the occurrence of small rock outcrops over the DZP Site, it is possible that all three species have roost sites located in the DZP Site. However, the removal of small cracks and fissures are unlikely to affect the life cycle of the species such that a viable local population is likely to be placed at risk of extinction. Furthermore, pre-clearing checks of hollow-bearing trees would ensure that all animals are relocated.

No breeding habitat (caves or similar subterranean habitats) would be removed by the proposed works although more suitable rocky crevices occur on Dowds Hill to be included in the proposed BOA. If used at any time, the potential foraging habitat that occurs within the DZP Site is a very minor component of the habitat available and species mobility would enable them to relocate easily to alternative habitats.

It is possible that the Proposal would reduce the extent of a feeding resource within the DZP Site, however, it is unlikely that a local population of any of the bat species would be placed at risk of extinction due to the large amount of analogous habitat adjoining the DZP Site.

4.7.6.7.11 Pink-tailed Worm-lizard

Originally identified by Goldney (2002) over the open cut (Habitat Area 1) and on the slopes of Dowds Hill (Habitat Area 3), a further 35 records of this species have been identified on the DZP Site.

Currently the records of the species within the separate Habitat Areas are considered separate sub-populations, as these are generally separated by areas of non-suitable habitat. Therefore, as the sub-population identified on Hill 1 occurs within the impact footprint of the proposed open cut, it could be considered likely to be disrupted such that this sub-population is placed at risk of extinction. OzArk (2013a) reports, however, that this sub-population is most likely not isolated and abuts (or is continuous with) the sub-population within Habitat Area 2 which would remain undisturbed. Furthermore, the proposed staging of disturbance over the open cut and enhancement of habitat between Habitat Areas 1, 2 and 3 would allow for both passive and active relocation of the species to occur before Habitat Area 1 is removed in its entirety.

A Recovery Plan for the Pink-tailed Worm-lizard was published for Canberra in 1995. Habitat removal is not consistent with this plan, however, the various mitigation and offset measures proposed by the Applicant (and incorporated into the *Pink-tailed Worm-lizard Plan of Management*) (see Sections 4.7.5.2 to 4.7.5.4) would provide for local protection and recovery of the species.

A local population of this species would be impacted by the Proposal. However, through targeted impact avoidance and mitigation, preparation and implementation of a *Pink-tailed Worm-lizard Plan of Management* and development of the proposed BOA which includes specific conservation and enhancement of Pink-tailed Worm-lizard habitat, the impacts are assessed as acceptable. Notably, the proposed BOA meets the required benchmarks for both the OEH Interim Policy and EPBC Act Offset Policy.

4.7.6.7.12 Fuzzy Box on Alluvials of South West Slopes, Darling Riverine Plains and the Brigalow Belt South EEC

The very small area of this EEC to be impacted (0.1ha) consists of isolated trees in highly disturbed agricultural land. The remaining occurrence of this EEC on the DZP Site has been avoided, with 21.9ha contained within the proposed BOA. The Proposal would not place this EEC at risk of local extinction.

While the Proposal would result in a small area of this EEC being removed, this is unlikely to cause impact such that it is placed at risk of local extinction. In fact, the inclusion of this EEC in the proposed BOA is likely to improve connectivity of isolated remnants of this EEC.

4.7.6.7.13 White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland)

Areas of this EEC to be impacted (43.3ha) consist of isolated trees in highly disturbed agricultural land. This area has been reduced as far as practicable by modifications to the DZP Site layout with significant areas to be included in proposed BOA (305.8ha) This EEC occurs elsewhere in the locality in various remnants and would not be placed this at risk of local extinction.

A Draft National Recovery Plan exists for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland. In line with the aims and objectives of this plan, the proposed BOA would provide for a significant habitat corridor connecting Dowds Hill to Wambangalang Creek.

While the Proposal would result in a small area of this EEC being removed, this is unlikely to cause impact such that it is placed at risk of local extinction. In fact, the inclusion of this EEC in the proposed BOA is likely to improve connectivity of currently isolated remnants of this EEC.

4.7.6.7.14 Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions

The very small area of this EEC to be impacted (1.08ha) occurs within a long linear remnant within the Obley Road reserve. Significant areas of this EEC would remain such that the Proposal would not place this EEC at risk of local extinction.

While the Proposal would result in a small area of this EEC being removed, this is unlikely to cause impact such that it is placed at risk of local extinction.

4.7.6.7.15 Migratory Species Listed under the EPBC Act

The Great Egret, Cattle Egret, White-bellied Sea-Eagle, Australian Painted Snipe, Latham's Snipe, White-throated Needletail, Fork-tailed Swift, Rainbow Bee-eater and Australasian Bittern could be transitory visitors to the Application Area, however, there is little evidence to suggest that the DZP Site supports 'important habitat' for migratory species. The proximity of wetlands of international importance downstream on the Macquarie River (Narran Wetlands, Macquarie Marshes) also reduces the likelihood that habitat in the DZP Site is ‘important habitat’.

Given the DZP Site is not considered to be an area of 'important habitat' for migratory birds, whether they are wetland or terrestrial species, and considering the relatively restricted areas to be cleared for the Proposal, it is assessed as unlikely that any of these migratory birds would rely on habitat in the DZP Site.

4.7.6.8 Other Indirect Impacts on Biodiversity

Indirect ecological impacts of the Proposal may include the following.

- Loss of habitat and wildlife corridors due to vegetation removal.
- Increased competition for resources from introduced species or increased predation from changes in habitat.
- Changes in hydrology, erosion or sedimentation which could lead to changes in vegetation assemblages.
- Disruption to essential behavioural patterns because of noise, artificial lighting, dust, road traffic or human interference.
- Mortality due to drinking polluted waters.
- Mortality due to uncontrolled bush fires.

The following presents an assessment of each of the potential indirect impacts.

Loss of Habitat

No critical fauna habitat occurs in the vicinity of the DZP Site as designated by the Register of Critical Habitat held by the Commonwealth Minister of the Environment, Heritage and Arts and the Register of Critical Habitat held by the Director-General of the OEH.

The planned removal vegetation for the Proposal does not significantly increase the fragmentation of the retained vegetation. In fact, the proposed BOA would increase habitat linkages and the quality of the habitat contained within these linkages.

Increased Competition / Predation

Existing edge effects associated with the encroachment of weeds and feral species from paddocks adjoining the existing native woodland remnants are a feature of the local setting. The creation of additional disturbed land could attract introduced species such as House Mouse, Red Fox, Rabbit and Cat to the area. However, with the implementation of a waste management and pest control strategy, the impact of introduced species would be minimal. Furthermore, the Applicant is committed to a feral pig control program within the Dowds Hill component of the proposed BOA which would reduce the potential for impacts on species such as the Pink-tailed Worm-lizard.

An additional increase in edge effects in the vicinity of the proposed residue storage facilities may result in hydrological changes and weed invasion. However, none of these local changes would result in any of the species or communities of conservation significance being placed at risk of extinction.

Changes in Hydrology

The Applicant would implement the sediment and erosion control measures identified in Section 4.5.4.2. As a result, the Proposal would not result in significant changes to the hydrology of watercourses within the DZP Site and indirect impacts on vegetation communities would not be significant.

Disturbance by Noise and Dust

Excessive dust generation can impact on the health and viability of surrounding vegetation and indirectly affect fauna populations. Such an impact would be limited and any dust effects would be mitigated by a rigorous suppression regime through regular watering of roads and soil stockpiles, emplacements and other active areas within the DZP Site.

While it is acknowledged that excessive and sudden noise can affect the presence and breeding ability of some fauna species, it is also accepted that many species adapt to human activities and readily habituate to noise. A range of fauna species are known to inhabit land within and surrounding the DZP Site that have adapted to human activities and it is expected that such species would continue to occupy the general area.

As a result, indirect impacts associated with disturbance by noise and dust are considered unlikely to be significant.

Artificial Lighting

Artificial lighting for the Proposal has the potential to affect the behavioural patterns of some fauna species, for example, attracting birds and bats to feed upon insects attracted to lights. Although such situations can result in increased predation, there is no evidence of this phenomenon within existing lighting set-ups at similar mines in the region and it is unlikely that the impacts from artificial lighting within the DZP Site would have an adverse impact.

Lighting at the DZP Site would be concentrated close to the existing village of Toongi.

Mortality due to Ingestion of Polluted Water

Potential exists for fauna to drink water ponded within the LRSF. However, while saline, this water would not contain poisons or other contaminants likely to result in fauna mortality. In any event, given the brine to be discharged to the LRSF would have a salinity of over 60 000µS/cm, it is not expected that fauna would attempt to drink the water. As a result, impacts associated with mortality due to ingestion of polluted water are not expected.

Bush Fire

The potential for a change in the frequency of fires due to the Proposal would be reduced through implementation of the measures identified in Section 4.14.3.5. As a result, bush fire frequency and intensity, within and surrounding the DZP Site is not expected to change as a result of the Proposal.

4.8 AQUATIC ECOLOGY

4.8.1 Introduction

The Director-General's Requirements issued by DP&I identified "***Biodiversity***" as a key issue for assessment – including:

- *measures taken to avoid, reduce or mitigate impacts on biodiversity;*
- *a detailed assessment of potential impacts of the development on any:*
  - *terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems;*
- *a comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term.*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Department of Primary Industries (DPI) which requests that "*the EIS should specifically address the impacts on the aquatic ecology, waterway crossings, off-site impacts, threatened species and proposed offsets and compensatory habitats*". The DPI also requests specific assessment of the impact of proposed waterway crossings and the extraction of water from the Macquarie River on the aquatic environment and aquatic species, populations and communities.

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to aquatic ecology and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Reduced surface flows to Wambangalang and other creek catchments / tributaries of the Macquarie River (low to medium).
- Degradation of riparian or aquatic vegetation / ecosystems (low).
- Degradation of aquatic habitats through reduced environmental water flows (low).
- Pollution of local and downstream waterways resulting in detrimental effects to flora and fauna (low).
- Increased sediment load in drains and/or waterways (medium).
- Direct adverse impact on threatened species, populations and communities (high).
- Local or regional reduction in distribution of threatened species, populations and endangered ecological communities (high).

The aquatic ecology assessment for the Proposal was undertaken by Dr Alison Hunt of Alison Hunt & Associates Pty Ltd (AHA). The resulting report is presented as Part 7 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as "AHA (2013)". This subsection of the EIS provides a summary of that report, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**. It is noted that surface water is addressed in Section 4.5 and groundwater in Section 4.6.

4.8.2 Local Setting

The DZP Site is located within the Central West region and Central West CMA which includes the Castlereagh, Bogan and Macquarie River valleys. The catchment covers an area of 92 000 km^2, from the central tablelands around Oberon, Bathurst and Rylstone to the western plains around Nyngan and Coonamble. Ephemeral drainage on the DZP Site radiates from a roughly central location coinciding with the open cut and flows to the Macquarie River via three catchments, Wambangalang Creek, Cockabroo Creek (via Little River) and an unnamed drainage line which flows directly into the Macquarie River. Section 4.1.2 provides an overview of the hydrological conditions of these catchments and **Figures 4.1** to **4.3** provide the regional, local and DZP Site hydrological setting.

A reduction in water quality has occurred in almost all streams throughout the catchment with increasing trends in chemical contamination (nutrients and pesticides), temperature, bacteria levels, heavy metals, turbidity, salinity and pH. Due to the nature of the Macquarie River, most salt generated in the uplands and slopes is deposited back into the landscape through irrigation or floodplain entrapment or it is deposited in the wetlands and effluent systems of the western areas. Reduced water quality impacts detrimentally on aquatic habitat.

The "State of the Catchments 2010" report of DECCW (2010b) reports that the overall fish condition, an indicator of aquatic ecological conditions, in the Central West region ranged from poor in the Bogan River lowlands, to very poor in the Macquarie River lowlands, slopes and

uplands and extremely poor in the Bogan slopes, Macquarie highlands and all zones in the Castlereagh catchment. DECCW (2010b) also reports that the proportion of the fish assemblage that is native versus introduced was poor in the Macquarie slopes and Bogan lowlands, very poor on the Bogan and Castlereagh slopes and in the Macquarie and Castlereagh uplands and Macquarie highlands, and extremely poor in the Macquarie and Castlereagh lowlands.

The Macquarie Marshes (approximately 210 km northwest of the DZP Site) is one of the largest remaining inland semi-permanent wetlands in south-eastern Australia. It is recognised as an area of international importance for waterbird breeding and was listed as a Ramsar site in 1986.

4.8.3 Aquatic Ecology Survey

4.8.3.1 Introduction

For the purposes of the assessing the potential impacts of the Proposal, the aquatic ecology study area comprises the DZP Site, as well as Wambangalang Creek upstream and downstream of the DZP Site, Hyandra Creek to the northwest of the DZP Site and Cockabroo Creek, Little River and Macquarie River downstream of the DZP Site. These additional areas were included in investigations to provide a broader view and baseline information on the status of aquatic ecosystems beyond the DZP Site.

Within the context of this study area, and the broader local setting described in Section 4.8.2, the desktop and field survey completed by AHA (2013) included:

- a review of available literature and databases to assist with the identification of the values of the DZP Site and locality, especially in relation to threatened aquatic species, populations and endangered ecological communities (EECs), and groundwater dependent ecosystems (GDEs);
- a scoping assessment of the DZP Site and local setting to allow development of a detailed methodology; and
- field surveys to ascertain the current condition and the presence or likely presence of threatened or protected species within the DZP Site and study area.

The following subsections provide further an overview of this survey, a more detailed description of which is provided by AHA (2013).

4.8.3.2 Literature Review and Consultation

AHA (2013) reviewed the following guidelines, databases and search tools primarily focussing upon identifying the threatened aquatic species, populations and communities which may occur within the Central West CMA and which could be affected by the DZP,.

- The NSW Department of Primary Industries - Fisheries *What is Currently Listed?* Online resource.
- Office of Environment and Heritage (OEH) threatened species database records.

- DSEWPaC Online protected matters search tool for Matters of National Environmental Significance.
- DSEWPaC online species profile and threats database.
- DSEWPaC online register of critical habitat.
- DSEWPaC Survey guidelines for Australia's threatened fish. Guidelines for detecting fish listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*.
- *Status of Vertebrate Fauna and Their Habitat in the Central West Catchment* (Goldney et al., 2007).
- Little River Catchment Management Plan. Stage 1 Report. Riverine Environment (Little River Landcare Group, 2001).

In addition, Mr Dave Ward of NSW DPI Fisheries was consulted regarding the likely suite of threatened communities, populations and species which would be targeted by field survey. Mr Matt Hansen, a local fishing identity, was also consulted about species known from the area, preferred local habitat types and recent fish sightings and capture.

4.8.3.3 Classification of Watercourses

Strahler stream order and Industry & Investment (I&I NSW) classifications were used to broadly categorise watercourses within the DZP Site and study area. **Table 4.54** provides the I&I NSW fish habitat classification system.

Table 4.54
Fish Habitat Classification in NSW Waterways

Classification	Characteristics of Waterway Type
Class 1 Major fish habitat	Major permanently or intermittently flowing waterway (e.g. river or major creek). Habitat of a threatened fish species or 'critical habitat'.
Class 2 Moderate fish habitat	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area.
Class 3 Minimal fish habitat	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.
Class 4 Unlikely fish habitat	Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present).

4.8.3.4 Preliminary Assessment and Site Selection

In February 2012, an initial site inspection and preliminary investigation into the condition of watercourses, habitat available and adjacent land use was completed. The preliminary assessment had two objectives.

1. To identify habitat likely to be suitable habitat for those threatened species, population and communities identified as potentially occurring within the study area following literature review (see Section 4.8.3.2).
2. To confirm and establish suitable survey and sampling sites.

A total of 22 sites were evaluated with 10 of these selected for more detailed assessment. **Figure 4.37** provides the locations of the 10 survey sites. For further detail on each site, refer to *Table 3* and *Appendix B* of AHA (2013).

4.8.3.5 Field Survey

A four day field assessment was undertaken between 19 to 23 February 2012 incorporating the following surveys/assessments.

Aquatic Health Assessment

Aquatic health assessments were undertaken for all survey sites to identify the habitat type available, the quality of habitat, the overall health of the waterway and the potential for these areas to provide habitat for species, populations and communities listed under the FM Act, TSC Act and EPBC Act.

Habitat Assessments

Habitat assessments undertaken were based on NSW AUSRIVAS protocols using FNARH Field Datasheets. Habitat variables such as benthic substrate, water depth and vegetation / water % coverage (including shading) were recorded.

Field Water Quality

A YEO-KAL YK611 hand held, multi-probe water quality meter was used to record in situ water quality at each site. Parameters measured include pH, turbidity (NTU), conductivity (µs/cm), temperature (ºC), dissolved oxygen (% saturation and mg/L). The water quality data were analysed against the Australian and New Zealand Marine and Fresh Water Quality Guidelines (ANZECC, 2000).

Macrophyte and Emergent Vegetation

At each site, the emergent vegetation and macrophytes were recorded. The emergent vegetation and macrophyte surveys were undertaken to record species abundance and richness, and was quantitatively surveyed using 5m wide, 25m long transects which provided stratified mapping of communities.

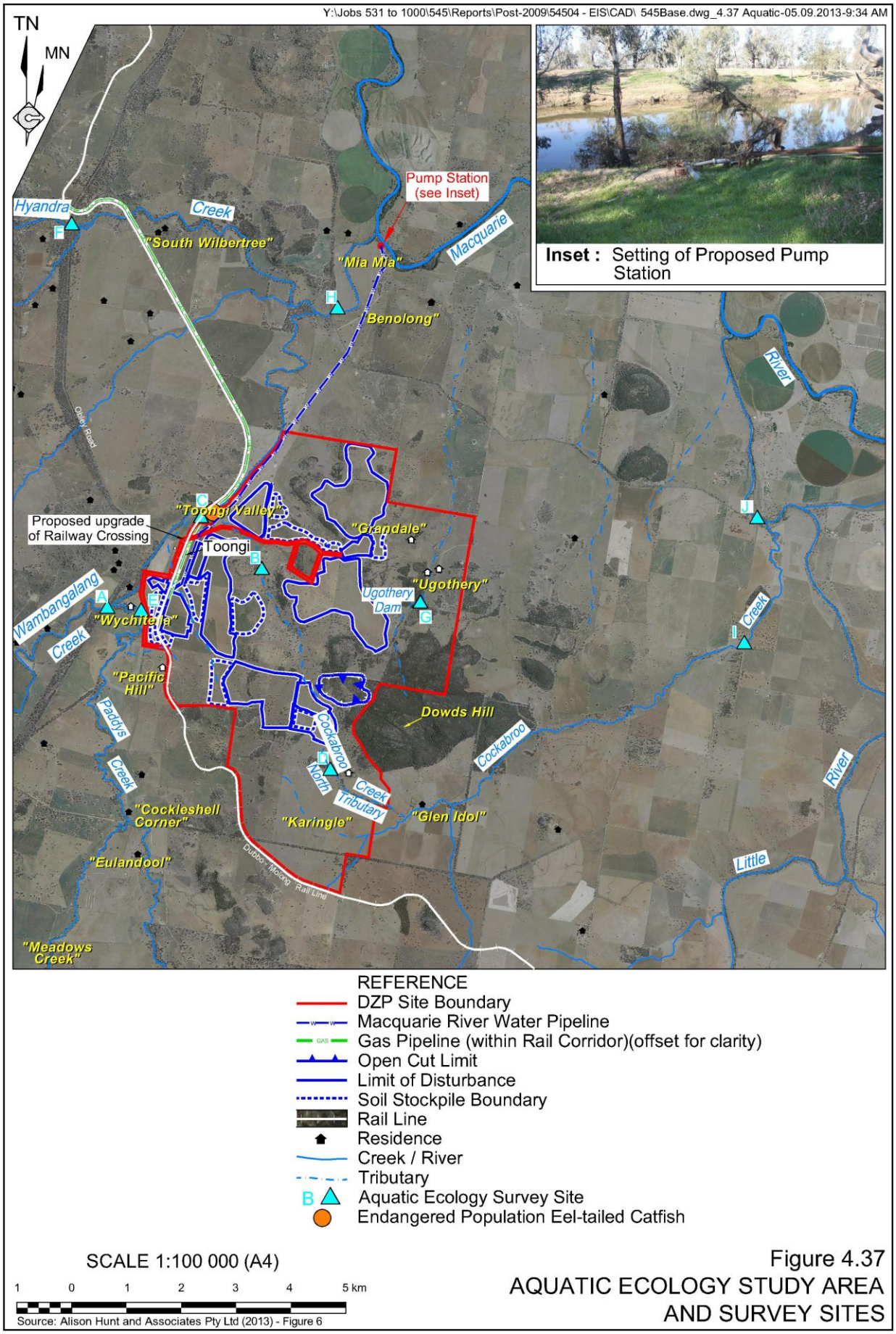


Figure 4.37
AQUATIC ECOLOGY STUDY AREA AND SURVEY SITES

Targeted Threatened Species Surveys

Based on the threatened aquatic species and populations identified as potentially occurring within the study area following literature review and consultation (see Section 4.8.3.2), a range of survey techniques were implemented.

Table 4.55 presents the survey techniques used to sample aquatic fauna species at the ten survey sites to increase the probability of sampling a wider range of species and size classes.

Table 4.55
Fauna Survey Techniques

Technique	Site									
	A	B	C	D	E	F	G	H	I	J
Bait Trap	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Opera house trap	✓	✓	✓			✓	✓	✓		
Fyke net		✓	✓					✓		
Seine net								✓		✓
Active searches	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Source: Modified after AHA (2013) - Table 3										

Other Surveys

Timed active searches for snails and other notable invertebrates were undertaken at each of the survey sites. Dead branches and rocks were overturned and macrophytes and emergent vegetation were also searched for the presence of invertebrate fauna.

4.8.4 Survey Results

4.8.4.1 Desktop Survey

In total, 24 fish species are known from the Central West CMA (Goldney et al, 2007) with 17 of these being native. Of the 7 introduced, three are identified as noxious under the FM Act, namely:

- Redfin Perch, *Perca fluviatilis*: Class 1.
- Eastern Gambusia, *Gambusia holbrooki*: Class 1.
- Common Carp, *Cyprinus carpio*: Class 3.

Table 4.56 presents the threatened species, populations, communities other aspects of conservation significance that are known to occur within the Central West CMA.

Table 4.56
Aquatic Biota and Other Features of Conservation Significance of the Central West CMA

Scientific Name	Common Name	Status	
		FM Act	EPBC Act
Species			
Ambassis agassizii	Olive Perchlet	E	
Bidyanus bidyanus	Silver Perch	V	
Maccullochella macquariensis	Trout Cod	E	E
Maccullochella peelii	Murray Cod		V
Mogurnda adspersa	Purple Spotted Gudgeon	E	
Populations			
Tandanus tandanus – Eel-tailed Catfish in the Murray/Darling Basin		E	
Western NSW population of the Olive Perchlet, Ambassis agassizii		E	
Endangered Ecology Community			
Aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River		E	
Wetlands of International Significance			
Macquarie Marshes			L
FM Act = *Fisheries Management Act 1994* EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999* *V = Vulnerable E = Endangered L = Listed*			
Source: AHA (2013) – Sections 5.1 and 5.2			

4.8.4.2 Strahler Stream Order and Waterway Classification

Waterways within the DZP Site and aquatic ecology study area range from 1st order streams at the headwaters of Cockabroo Creek Catchment, Macquarie (Undefined) River Catchment, Wambangalang Creek Catchment to the Macquarie River which is classified as a 4th order stream.

Table 4.57 presents the Strahler Stream Order and the Waterway Classification for the watercourses located in the aquatic ecology study area.

Table 4.57
Strahler Stream Order and Waterway Classification for the Aquatic Ecology Study Area

Waterway	Strahler Stream Order[1]	Waterway Classification[2]
Macquarie River	4	Class 1 – Major fish habitat
Little River	3	Class 1 – Major fish habitat
Wambangalang Creek	3	Class 1 – Major fish habitat
Hyandra Creek	2	Class 2 – Moderate fish habitat
Cockabroo Creek	2	Class 2 – Moderate fish habitat
Paddys Creek	2	Class 3 – Minimal fish habitat
Headwaters of creeks on the DZP Site	1	Class 4 – Unlikely fish habitat
Source: Modified after AHA (2013) – Table 10		

While the Macquarie River is known to provide habitat for a range of fish species, some of which are listed as threatened under State and Commonwealth legislation, headwaters of the catchments are unlikely to provide fish habitat due to their undefined channels and lack of water.

4.8.4.3 Aquatic Habitat

A standardised description of adjacent land and condition of riverbanks, channel and bed was recorded using the "Riparian, Channel and Environmental Inventory" (RCE), developed by the EPA, a method used to scale and quantify the environmental state of particular locations based on surrounding land use, geomorphology, channel bed forms, and riparian and in-stream vegetation. The highest possible score (52) is assigned to streams with no obvious physical disruption while the lowest score (13) is assigned to heavily disturbed streams.

Table 4.58 presents the RCE Score and qualitative water quality results.

Table 4.58
Aquatic Habitat RCE Scores

Site[1]	Waterway	RCE Score	Water Quality
A	Wambangalang Creek (Obley Road)	26	Very high salinity and low dissolved oxygen
B	Watercourse B tributary of Wambangalang Creek	19	High salinity and high turbidity
C	Wambangalang Creek (Toongi)	26	High Salinity
D	Unnamed tributary of Cockabroo Creek	23	Freshwater, high turbidity
E	Paddys Creek	21	High salinity, low dissolved oxygen
F	Hyandra Creek	33	High salinity
G	Watercourse A Ugothery Dam	29	Freshwater
H	Wambangalang Creek (Benolong Road)	25	High salinity
I	Cockabroo Creek (Nubingerie Road)	22	Very low salinity
J	Little River (Terrabella Road)	24	High salinity

Note 1: Refer to **Figure 4.37**
Source: Modified after AHA (2013) – Tables 11 and 12

Paddys Creek, Wambangalang Creek and Cockabroo Creek have been substantially altered and have experienced impacts due to upstream and adjacent land use practices including, roads, clearing, weed invasion, alteration of flows, cropping, erosion, sedimentation and salinization. This is reflected in RCE scores for upstream sites of the Proposal, Site B – unnamed tributary of Wambangalang Creek (RCE 19), Site E – Paddys Creek (RCE 21) and downstream sites of Site I Cockabroo Creek Nubingerie Road (RCE 22) and Site J – Little River (Terrabella Road) (RCE 24). Site F – Hyandra Creek, not to be impacted by the Proposal, represented a moderate aquatic habitat value of RCE 33. More detailed descriptions of the aquatic habitat and water quality of each site are provided in AHA (2013) (Part 7 of the Specialist Consultant Studies Compendium).

4.8.4.4 Aquatic Fauna

Table 4.59 presents the aquatic fauna species recorded at each of the survey sites (see **Figure 4.37**).

Table 4.59
Recorded Aquatic Fauna

Scientific Name	Common Name	Survey Sites									
		A	B	C	D	E	F	G	H	I	J
Carassius auratus[1]	Goldfish					✓					
Chelodina longicollis	Eastern Snake-necked Turtle		✓	✓					✓		
Cherax destructor	Common Yabby	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cyprinus carpio [1]	Common Carp										✓
Gambusia holbrooki [1]	Eastern Minnow	✓	✓	✓		✓	✓		✓		
Hypseleotris klunzingeri	Western Carp Gudgeon								✓		✓
Tandanus tandanus [2]	Eel-tailed Catfish			✓							

Note 1: Noxious fauna under the FM Act (see Section 4.8.4.1) Note 2: Endangered Population (FM Act)
Source: Modified after AHA (2013) - Table 14

With the exception of the Eel-tailed Catfish (recorded at Site C – see **Figure 4.37**), all native fauna species recorded are considered relatively common within the Central West Catchment area (Goldney, 2007). The Eel-tailed Catfish is non-migratory and can live in a wide range of habitats and can adapt to increased levels in salinity and turbidity. Remnant populations of the Eel-tailed Catfish occur within the Macquarie catchment upstream of Warren, the Castlereagh catchment upstream of Mendooran, the Namoi catchment upstream of Wee Waa, the Gwydir catchment upstream of Moree and the Border Rivers catchment upstream of Goondiwindi.

4.8.5 Potential Impacts on Aquatic Ecology, Mitigation and Management

4.8.5.1 Introduction

Considering the proposed activities and receiving environment, AHA (2013) has identified a number of potential impacts of the Proposal on aquatic ecology. The following considers each along with the proposed mitigation or management to be implemented to avoid or minimise impacts.

4.8.5.2 Alteration of Natural Surface Flows

Potential Impact

Up to 650ha of the DZP Site would be excluded from the headwaters of the upper reaches and headwaters of tributaries to the Wambangalang Creek, Cockabroo Creek and Macquarie River catchments. This could result in some minor changes to flow patterns and volumes which could alter abundance and distribution of aquatic fauna and flora.

The estimated loss from each catchment and the overall reduction in flows within the catchment are shown in **Table 4.60**.

Table 4.60
Estimated Loss of Surface Water Runoff

Catchment	Estimated Loss (MLpa)	Estimated Reduction in Flow (%)
Wambangalang Creek	337	1
Watercourse A (Macquarie River)	95	17
Cockabroo Creek	20	5
Source: Modified after AHA (2013) – Table 17		

Mitigation

Iterative refinement of the footprint of the DZP, in particular reduction in the size and number of storage areas and alteration of the shape of Liquid Residue Storage Facility, has reduced this loss in upper catchment to the smallest area practical. Notably, the estimated loss within the Wambangalang Creek catchment, which would experience the most substantial alteration to flows from surface water runoff, is only 1%.

4.8.5.3 Obstruction of Fish Passage due to In-stream Structures

Potential Impact

The construction and operation of the DZP has the potential to obstruct movement of aquatic biota as a consequence of the construction of road and rail crossings and laying of pipelines. The disruption of movement patterns along streams can effectively isolate populations resulting in their gradual decline and in some cases local extinction.

Mitigation

All new structures across watercourses would be designed and constructed in line with the *Guidelines and Policies for Aquatic Habitat Management and Fish Conservation* (NSW Fisheries, 1999) and *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge, 2003).

Pipelines across perennial watercourses would be installed by directional drilling (under-boring) methods or possibly hung below the rail line for larger bridge crossings such as that of the Macquarie River. Pipelines across ephemeral watercourses would be installed by trench excavation during periods of no flow within the channels and in accordance with *Controlled Activities on Waterfront Land Guidelines 2012* for laying pipes and cables in watercourses on waterfront land.

4.8.5.4 Removal and Disturbance of Riparian Vegetation

Potential Impact

Riparian vegetation provides important habitat and aides in the management of water quality within downstream aquatic habitats. The Proposal would require some minor areas of clearing along local watercourses.

Mitigation

The DZP impact footprint has been designed with due regard to the retention of floodplain areas and riparian vegetation and this has reduced the potential for impacts. In particular, the location of components such as the solid and liquid residue storage facilities were chosen to remain at least than 200m from the Wambangalang Creek and 50m from other major watercourses through the DZP Site, thereby avoiding remnant riparian vegetation.

To ensure that the remaining riparian corridors are not further impacted by the Proposal, the Applicant would implement the following measures.

- Mark exclusion zones around riparian vegetation to avoid potential impacts.
- Exclude stock from the riparian corridor within the DZP Site.

Management measures to protect riparian areas from off-site impacts would include an *Erosion and Sedimentation Control Plan* prepared for construction and operation of the DZP. This would include the provision for minimising clearing of vegetation across the DZP Site and the appropriate location of silt fences and sediment traps.

It is also noted that the proposed *Biodiversity Offset Strategy* for the DZP includes habitat enhancement between Dowds Hill and Wambangalang Creek, incorporating Watercourse B. This would provide for improved water quality discharging to Wambangalang Creek upstream of the identified population and subsequently improvement in the habitat quality of Wambangalang Creek more generally.

4.8.5.5 Mobilisation of Sediment During Construction

Potential Impact

The Proposal would involve significant earthworks which has the potential to mobilise sediments into watercourses. The mobilisation of sediments into watercourses can result in:

- smothering of vegetation and an increase in light attenuation which can decrease the productivity of in-stream vegetation and increase mortality;
- an increase in nutrients which can cause eutrophication;
- infill of habitat refugia and smothering of spawning habitat; and
- decrease in growth rates and mortality as suspended particles can obstruct gills and feeding structures of fish.

Mitigation

An *Erosion and Sediment Control Plan* would be implemented by the Applicant for all phases of the Proposal to minimise the discharge of sediment from the DZP Site and other areas of construction, e.g. water pipeline installation, road upgrades.

4.8.5.6 Changes in Water Quality

Potential Impact

Construction and operational activities across the DZP Site have the potential to reduce water quality through contamination of watercourses as a consequence of runoff of contaminants from the site during construction and operation.

Mitigation

All hazardous and potentially contaminating materials would be contained within bunded areas and on impermeable surfaces (see **Figure 2.11**).

4.8.5.7 Water Extraction

Potential Impact

The extraction of up to 4.05GL of water from the Macquarie River could impact on aquatic biota through:

- entrainment and loss of eggs, larvae, and juvenile fish (including threatened species) extracted via the pump and pipeline system;
- mechanical damage and fish mortality from pumps;
- impacts on refuge pools, key fish habitats and threatened species habitat due to extraction during low flows; and
- alterations to the existing hydrology within the Macquarie River as a result of extraction.

Mitigation

To mitigate against entrainment of aquatic biota, the intake system would be fitted with a Johnson Screen with a maximum 2mm mesh size and ideally have an approach velocity no greater than 0.4m/s. The screen would be placed parallel, or at a slight angle to the direction of flow, to assist fish that come into contact with the screen to brush gently against the screen and continue on downstream. Pumping protocols would require that pumping rates gradually increase and decrease at the commencement and cessation of pumping cycles.

Water would be extracted from the Macquarie River under licence and in accordance with instructions regarding allocations provided by the NSW Office of Water. The extraction point has been located at an existing pump take-off point on the "Mia Mia" property where the river is at its deepest (see inset of **Figure 4.37**).

The Applicant has committed to monitoring water and aquatic biota conditions (in accordance with AUSRIVAS) to ensure that the extraction activities do not result in detrimental outcomes. The Applicant completed an initial monitoring campaign in March 2013 which will be repeated in spring 2013, to provide baseline conditions against which future monitoring can be assessed.

4.8.5.8 Disturbance of Freshwater Eel-tailed Catfish Habitat at Toongi

Potential Impact

The recorded Eel-tailed Catfish and habitat at Toongi occurs within a relatively deep pool (approximately 1.5m deep), approximately 50m upstream from the wooden rail bridge which crosses Wambangalang Creek. While the Eel-tailed Catfish appears to be adapted to increased levels of salinity and turbidity, and therefore unlikely to be affected by any minor changes to hydrology resultant from the Proposal, the potential for bridge upgrade activities to directly impact on this population remains.

Mitigation

Reconstruction of the bridge across Wambangalang Creek would be undertaken in such a manner so as to not to impact upstream habitat or change the current habitat regime. The design principles outlined in the *Guidelines and Policies for Aquatic Habitat Management and Fish Conservation* (NSW Fisheries, 1999) and *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge 2003) would be incorporated into the design of the bridge. During construction works, flows would be maintained within the creek reflecting the conditions at the time of construction.

Ultimately, the proposed habitat enhancement proposed between Dowds Hill and Wambangalang Creek along Watercourse B would provide for improved water quality discharging to Wambangalang Creek upstream of the identified population and subsequently improvement in the habitat quality of Wambangalang Creek more generally.

4.8.5.9 Removal and Disturbance to an Endangered Ecological Community

Potential Impact

The Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River EEC is present along all watercourses in the study area up to 500m AHD. While direct impacts from the Proposal on this EEC are likely to be minimal, some indirect impacts may occur as a result of:

- altered floodplain and wetland inundation as a result of in-stream structures; and
- degradation of the riparian zone through clearing of native vegetation and stock access, leading to loss of shelter and increased sedimentation.

This community would be susceptible to changes in the hydrology of the catchments in the study area and impacts on this community could be far reaching as several components of this EEC (e.g. macroinvertebrates and terrestrial insects) provide important resources in the aquatic food chain.

Mitigation

Measures proposed to manage other potential impacts on aquatic habitat and water quality would also mitigate against impact on this EEC. Furthermore, the monitoring program commenced in March 2013 would provide clear evidence if the Proposal is adversely impacting the aquatic habitat or water quality within the study area, which includes this EEC. In the event of evidence of adverse impacts, the Applicant would implement additional mitigation measures to be developed in consultation with the appropriate government agency(ies).

4.8.6 Assessment of Residual Impacts

4.8.6.1 Introduction

Considering the potential impacts of the DZP, and proposed mitigation measures to be implemented, the following provides an assessment of the Proposal with respect to:

- Aquatic habitat management generally (Section 4.8.6.2); and
- The aquatic ecology of conservation significance noted in **Table 4.56** as having been identified or potentially occurring with the study area (Section 4.8.6.3).

4.8.6.2 General Impact Assessment

Streams, creeks and watercourses within the boundaries of the DZP Site, across the study area and locality have been degraded through clearing, agriculture and water abstraction over many years. These impacts have resulted in:

- changes in water quality from erosion and sedimentation, increased inputs of nutrients and increased salinisation of the study area;
- clearing of vegetation and in-stream snags, which has resulted in the simplification of habitat structure as in-stream vegetation and overhanging vegetation has largely been removed and weeds have become established; and
- changes to drainage patterns through the construction of farm dams, bridges and causeways, which has disrupted dispersal patterns.

Although the development of the DZP would be undertaken across aquatic ecosystems that are stressed and degraded, the watercourses still provide habitat for aquatic biota. This includes habitat for threatened species, populations and endangered ecological communities such as the Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River and *Tandanus tandanus* – Eel-tailed Catfish in the Murray/Darling Basin Endangered Population. AHA (2013) has reviewed the potential impacts and concludes that through an iterative reduction in the impact footprint, and adoption of the mitigation, management and offset measures noted in Section 4.8.5, these impacts would be reduced to acceptable levels.

4.8.6.3 Aquatic Ecology of Conservation Significance

4.8.6.3.1 Threatened Species, Populations and Communities

AHA (2013) completed assessments of significance for the species, populations and communities listed in **Table 4.56** in accordance with the Significant Impact Criteria of the *EPBC Act Policy Statement 1.1 – Significant Impact Guidelines: Matters of National Environmental Significance (DEWHA, 2009)* and the *Threatened Species Assessment Guidelines: The Assessment of Significance (DECC, 2007b).*

The following provides a brief summary of these assessments, which are provided in full as *Appendices E* and *F* of AHA (2013).

Trout Cod (*Maccullochella macquariensis*)

Listed as Endangered under the FM Act and EPBC Act, Trout Cod are often found close to cover and in relatively fast currents, especially in fairly deep water close to the bank, and often congregate around snags. Given its propensity for relatively fast currents and fairy deep water, it is unlikely that this species would be present due to lack of habitat and therefore the potential for direct impacts on this species is very unlikely. AHA (2013) considers it unlikely that the Proposal would impact any local or regional population of Trout Cod.

Murray Cod (*Maccullochella peelii peelii*)

Listed as Vulnerable under the EPBC Act, Murray Cod is generally found in areas sheltered by rocks, wood or overhanging banks, with wood debris being an essential habitat feature used for sheltering from currents. Whilst Murray Cod are known from the Macquarie River, and anecdotal reports suggest from the Little River, it is unlikely that any of the smaller tributaries would regularly provide habitat for this species. AHA (2013) considers it unlikely that the Proposal would impact any local or regional population of Murray Cod.

Western NSW population of the Olive Perchlet (*Ambassis agassizii*)

Listed as an Endangered Population under the FM Act, this species is usually found in slow-flowing or still waters, often near overhanging vegetation or amongst logs, dead branches and boulders. They often congregate around suitable shelter (e.g. large woody debris (snags) and vegetation) during the day but disperse during the night to feed on micro-crustaceans and insects, including larvae (Fisheries Scientific Committee, 2009; McNeil et al, 2008). It is considered unlikely that this species would occur in the waterways of the DZP Site as the waterways are ephemeral headwaters and / or highly degraded creeks suffering from many of the recognised threats for this species. AHA (2013) considers it unlikely that the Proposal would impact any local or regional population of Olive Perchlet.

Tandanus tandanus – Eel-tailed Catfish in the Murray/Darling Basin

Eel-tailed Catfish of this Endangered Population (under the FM Act) were recorded within the Wambangalang Creek at Site C. This species may also be present in other sections with suitable habitat (e.g. deep pools and snags) of the creek as well as the Macquarie and Little Rivers. The Eel-tailed Catfish is non-migratory and lives in a wide range of habitats including rivers, creeks, lakes, billabongs and lagoons, and although it inhabits flowing streams, it prefers sluggish or still waters. It can be found in clear to turbid waters, and over substrates ranging from mud to gravel and rock. AHA (2013) concludes that assuming the implementation of stringent environmental management of the upgrade of the wooden rail bridge across Wambangalang Creek, this population could be adequately protected to such an extent that this Proposal would be unlikely to significantly impact this endangered population.

Purple Spotted Gudgeon (*Mogurnda adspersa*)

Listed as Endangered under the FM Act, this species is generally found in slow-moving or still waters of rivers, creeks and billabongs, often amongst weeds, rocks or large snags. The only known naturally occurring population in the Central West is 47km southeast of the DZP Site in a small tributary that flows into the Macquarie River downstream from the Burrendong dam wall. There is potential habitat present in Macquarie and Little Rivers and some very marginal habitat in sections of Wambangalang Creek. However, this species is extremely vulnerable to competition from Eastern Gambusia which occurs throughout the DZP Site and study area, making it less likely that a population of this species would occur. AHA (2013) considers it unlikely that the Proposal would impact any local or regional population of Purple Spotted Gudgeon.

Silver Perch (*Bidyanus bidyanus*)

Listed as Vulnerable under the FM Act, Silver Perch are thought to prefer fast-flowing, open waters, especially where there are rapids and races, however they also inhabit warm, sluggish water with cover provided by large woody debris and reeds (NSW DPI Fisheries, 2005). There

are some pockets of potential habitat for this species in the Little River, Wambangalang Creek and Hyandra Creek, however, was not recorded during the surveys. AHA (2013) considers it unlikely that the Proposal would impact any local or regional population of Purple Silver Perch.

Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River

Listed as an Endangered Ecological Community (EEC) under the FM Act, this EEC is known to occur within the region. Aquatic communities of the Macquarie River, Little River, Wambangalang Creek, Cockabroo Creeks including the DZP Site, DZP study area and locality all support this EEC. It is unlikely that the Proposal would impact on this community due to the mitigation measures that are proposed to be implemented which minimises natural river flows and the degradation of riparian zones. AHA (2013) concludes that the DZP would be unlikely to substantially impact this EEC within the local catchment as flows would not significantly change from current levels, woody debris removed during construction would be replaced or relocated and riparian areas would be rehabilitated.

4.8.6.3.2 Wetlands of International Significance (Macquarie Marshes)

Under the Significant Impact Guidelines (DEWHA, 2009) an action is likely to have a significant impact on the ecological character of a declared Ramsar wetland if there is a real chance or possibility that it would result in:

- *"areas of the wetland being destroyed or substantially modified;*
- *a substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland;*
- *the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected;*
- *a substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health; or*
- *an invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland."*

The Proposal would not impact directly on the Macquarie Marshes and therefore not '*destroy or substantially modify'* any area of wetland. Furthermore, the Proposal would not promote the establishment or spread of any '*invasive species that is harmful to the ecological character of the wetland'*.

The potential for the Proposal to impact on the Macquarie Marshes revolves around any reduction in flow, or reduction in the quality of water reporting, to the Macquarie River upstream of the marshes and the possible impact this may have on the '*hydrological regime of the wetland', 'the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland', and/or 'water quality of the wetland'*.

The following considers the proposed extraction of water, controls in place to regulate this extraction and the likely impacts of this extraction on the Macquarie Marshes.

DZP Water Extraction

Water to supply the processing operations of the Proposal would be extracted from the Macquarie River from the "Mia Mia" property approximately 40km upstream of the Dubbo Gauging Station (No. 421001), 200m upstream of the confluence of Wambangalang Creek and 11km downstream of the confluence of the Little River. A maximum of 4.05GL of water would be drawn from this location each year.

The water drawn from the Macquarie River would be pumped to a storage dam and then to storage tank(s) within the processing plant from which a relatively constant supply would be provided to the various processing operations within the plant. Due to the reliance of the processing operations on a consistent supply of water, the extraction from the river would be similarly consistent and in the order of 10ML to 15ML per day.

Regulation of Water Extraction

The regulation of these rivers is governed by the *Water Sharing Plan for the Macquarie and Cudgegong Regulated River Water Source 2003* (the WSP). The WSP provides water for environmental needs and directs how much water is available for extraction and how it is to be shared. While the Macquarie Marshes are not part of the WSP area, the WSP includes rules about the release of flows to improve environmental outcomes for the Macquarie Marshes.

The WSP limits the long term annual average extraction from the Macquarie-Cudgegong system to 391GL/year. All flows above this are reserved for the environment. In the long term, approximately 73% of the average annual flow within the regulated river system is protected for environmental health. Water extraction is managed to ensure that these long-term environmental flows occur.

NOW undertakes resource assessments to determine what water allocations can be announced for consumptive users. The resource assessment ensures that water for the environment, river transmission losses and town water supply is assured prior to making other allocations available. Water is supplied to domestic and stock access licences and local water utility access licences before it is supplied to the high and general security water access licences (WALs) (which provide for the consumptive use of water other than for town water, domestic and stock watering purposes). Part 9, Division 3, Clause 46 of the WSP states:

> *"Where extraction components of access licences do not specify the rate as a share of supply capability or a volume per unit of time, the following priority of extractions shall apply whenever supply capability is insufficient to satisfy all orders for water in any section of this water source:*
>
> *a) water shall be supplied to domestic and stock access licences, local water utility access licences and regulated river (high security) access licences that have placed an order for water, then to regulated river (general security) access licences, and*
>
> *b) then any remaining supply capability shall be shared between regulated river (general security) access licences that have placed an order for water, in proportion to the share components specified on the access licences."*

Furthermore, there is currently an embargo on the allocation of new WALs within the WSP (other than for gazetted exemptions such as town water supply, cultural uses and others). Therefore, future allocations of water from the Macquarie River must be drawn from those WALs currently issued and held, i.e. there would be no increase in the total extraction limit of the WSP.

The 4.05GL of water to be drawn from the Macquarie River would be in accordance with the allocation allowed by a combination of high and general security WALs to be purchased from within the Macquarie River WSP. Based on the rules of the WSP and the enforcement of the WM Act, therefore, the delivery of water within the Macquarie River to town water supply and environmental flows would always take priority over other consumptive water uses. The DZP would not receive any allocation until the entire allocation for town water supply and environmental flows is assured.

It follows therefore, that the WALs obtained by the Applicant from within the area covered by the WSP *would not change the total amount of water in the system or the amount of water reaching the Macquarie Marshes*.

Impacts

On the basis that extraction of water from the Macquarie River is regulated under the WSP to maintain environmental flows, and extraction of up to 4.05GL of water is undertaken in accordance with the allocation defined for the general and high security WALs which have or would be acquired, this would have no impact on the volume of water flowing into the Macquarie Marshes.

As discussed in Section 4.8.5.2, the Proposal would result in a reduction in runoff to the three sub-catchments of the Macquarie River of approximately 452ML per year. Considered against the runoff generated by the total Macquarie River catchment to the Macquarie Marshes (~1 250 000ha), this is likely to represent less than 0.02% of total runoff.

The quality of water reporting to the creeks and their tributaries from the DZP Site and other component areas would be protected through implementation of environmental controls, in particular the implementation of an *Erosion and Sediment Control Plan* and containment of all liquid residues in a lined and appropriately designed LRSF. Furthermore, the quality of any discharged water would be regulated by an environment protection licence issued under the NSW *Protection of the Environment and Operations Act 1997* (POEO Act). The licence would protect the environmental health of downstream rivers including the Little and Macquarie Rivers.

Conclusion

The DZP Site and Macquarie River extraction point is remote from the Macquarie Marshes and would not result in any direct physical impacts. It would not measurably impact the hydrological regime of the marshes or the quality of water entering the marshes. Given that the hydrological regime of the marshes would not be affected, there is unlikely to be any significant impact on wetland dependent species, wetland vegetation, waterbird habitat, aquatic ecological communities and waterbird breeding sites. Furthermore, no mechanisms can be identified that could cause the DZP to affect the habitat or lifecycle of native species associated with the Macquarie Marshes or that could introduce or spread an invasive species.

On the basis of the above, it is concluded that the DZP would not have any significant impact on this wetland of international significance.

4.8.7 Monitoring

While the design of the Proposal indicates that impacts to aquatic ecosystems are negligible and can generally be managed through design and implementation of water management planning, it remains important that specific aquatic ecological factors are monitored throughout the life of the Proposal.

It is proposed that the monitoring program commenced by AHA in accordance with AUSRIVAS would be continued to assess impacts of the Proposal on aquatic ecology an conditions.

In addition, a monitoring program for Eel-tailed Catfish would be undertaken during suitable conditions throughout the life of the Proposal to identify whether the species utilises the areas of suitable habitat within Wambangalang Creek.

4.9 ABORIGINAL HERITAGE

4.9.1 Introduction

The Director-General's Requirements (DGRs) issued by DP&I identified "***Heritage****" as a key issue for assessment – including:*

- *an Aboriginal cultural heritage assessment (including both cultural and archaeological significance) which must:*
  - *demonstrate effective consultation with Aboriginal communities in determining and assessing impacts, and developing and selecting mitigation options and measures; and*
  - *outline any proposed impact mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures)."*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Office of Environment and Heritage (OEH) which requested that the EIS provide information addressing nine key points which would allow OEH to assess the impact of the Proposal on Aboriginal heritage. The Central West CMA also identified that "*the assessment must include the impacts on Aboriginal cultural heritage. information to demonstrate the impacts on Aboriginal heritage values, both archaeological and culturally in the broader sense*" and the Heritage Council of NSW advised that the EIS "*must include a heritage impact assessment that addresses …… the heritage significance of the site and any impacts the development may have upon this significance should be assessed*".

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to Aboriginal heritage and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Destruction of identified or currently unidentified Aboriginal sites and/or artefacts (medium to high).
- Cumulative reduction of the in-situ archaeological record through removal or destruction of identified or currently unidentified Aboriginal sites and/or artefacts (medium to high).

The Aboriginal Heritage Assessment for the Proposal was undertaken by various archaeologists of OzArk Environment and Heritage Management Pty Limited (OzArk) under the direction of Dr Jodie Benton. The resulting report is presented as Part 8 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as "OzArk (2013b)". This subsection of the EIS provides a summary of the Aboriginal heritage assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**. It is noted that non-Aboriginal (historic) heritage is addressed in Section 4.10.

4.9.2 Aboriginal Heritage Study Area

The Aboriginal heritage assessment considered a research study area for the Dubbo regional area to determine the ethno-history regional and local context. Additionally, a study area was considered for the surveys and included the following four areas**.**

- The DZP Site: comprising all areas of proposed Project-related disturbance associated with the open cut mining operations and related activities.
- The Macquarie Water Pipeline study area: a 7.6km long and approximately 20m wide corridor for the proposed water pipeline from the Macquarie River to the Project Site.
- The Toongi-Dubbo Rail Line and Gas Pipeline study area: a 30km long and approximately 10m wide area for the proposed upgrade of the rail line crossing over Wambangalang Creek.
- The Obley Road Alignment Area: a 22km long and approximately 20m wide corridor for the proposed realignment of portions of Obley Road between the DZP Site and Dubbo.

4.9.3 Assessment Methodology

The Aboriginal heritage assessment was undertaken in the following stages.

- Stage 1 – Consultation and Community Involvement.

  Stakeholder identification and registration was completed in accordance with the Aboriginal Cultural Heritage Consultation requirements for Applicants (ACHCRs) (DECCW, 2010). Consultation with each of the registered Aboriginal parties was then undertaken in accordance with the ACHCRs. Section 4.9.4 provides further detail on the consultation undertaken as part of OzArk (2013).

- Stage 2 – Background Research and Literature Review.

  An understanding of the archaeological context of the regional, local and DZP Site was obtained through a review of historic records of the local area, previous archaeological studies and the Aboriginal Heritage Information Management System (AHIMS) register of Aboriginal sites. This information is further discussed in Section 4.9.5.

- Stage 3 – Development of a Predictive Model for Site Location.

  Based on the background research and experience of OzArk, the archaeological sensitivities of landforms within the study areas were determined to predict the likely type and frequency of site types that may be identified. This allowed for the development of a more targeted field survey methodology. Section 4.9.6 provides further detail on the predictive model for site location and distribution.

- Stage 4a – Field Survey (Site Identification).

  Eight field surveys of the Study Area were undertaken between May 2012 and February 2013. Section 4.9.7 presents further detail on the site inspection methodology, coverage and results.

- Stage 4b – Field Survey (Test Excavations).

  Following the site identification stage of field survey, test excavations of Potential Archaeological Deposits (PADs) identified within the proposed impact footprint were completed. The objective of the test excavations is to confirm the nature and extent of archaeological deposits such that informed and appropriate management options may be developed for the sites. Section 4.9.7 presents further detail on the methodology, coverage and results of two test excavations completed.

- Stage 5 – Development of Management Strategies for the Identified Aboriginal Sites.

  Based on the relative cultural, scientific and public significance of the identified Aboriginal sites, management strategies have been recommended. These strategies have also been provided to the registered Aboriginal parties for consideration and comment. Section 4.9.8 presents further detail on the management strategies to be implemented for the identified Aboriginal sites.

- Stage 6 – Assessment of Impacts

  Considering the adoption of the proposed management strategies, the residual impact of the Proposal on Aboriginal cultural heritage was assessed. This took into account not only the direct impact on the identified Aboriginal sites, but also potential cumulative impacts on the regional archaeological record. Section 4.9.9 provides further details in relation to the assessment of impacts.

4.9.4 Consultation and Community Involvement

4.9.4.1 Consultation

4.9.4.1.1 DZP Site, Macquarie River Water Pipeline, Toongi-Dubbo Rail Line and Obley Road

Aboriginal community consultation for the Proposal was undertaken in accordance with the *Aboriginal Cultural Heritage Consultation Requirements* (ACHCRs) (DECCW, 2010). An expression of interest (EOI) advertisement was placed in the Daily Liberal to appear in the publication on the 7 January 2012. Additional letters were also sent to the following agencies or organisations.

- Office of Environment & Heritage (OEH).
- Dubbo City Council.
- Native Title Services Corporation Limited (NTSCORP).
- Central West Catchment Management Authority (CMA).
- National Native Title Tribunal (NNTT).
- Dubbo Local Aboriginal Land Council (LALC).
- Register of Aboriginal Owners.

In addition, letters were sent to known Aboriginal stakeholders associated with previous projects in the vicinity of the study areas, so that these individuals / organisations could be advised of the Proposal and invited to register interest.

A second round of letters was sent to additional groups identified as a consequence of the agency contact. At the conclusion of the Stage 1 notification phase of this process, four Aboriginal stakeholders registered an interest and were confirmed as Registered Aboriginal Parties (RAPs) in accordance with the ACHCRs.

- Binjang Wellington Wiradjuri Heritage Survey (BWWHS).
- Wirrimbah Direct Descendants (WDD).
- Diane Stewart.
- Dubbo LALC.[1]

Further letters presenting information regarding the Proposal and describing the proposed heritage assessment methodology (Stage 2 / 3 of the ACHCRs), were sent to all stakeholders with a request for input on the methodology proposed. Included with this correspondence was an invitation to attend an inception meeting on 24 April 2012 to introduce the Proposal and discuss the proposed methodology for the Aboriginal surveys and assessment.

Feedback from the consultation meeting and Stage 2 / 3 letters were incorporated into the methodology prior to fieldwork being initiated. Several positions were made available for Aboriginal community members to allow all stakeholders to be represented during the fieldwork and assessment period.

[1] It is noted that Mr Charlie Trindall registered interest on behalf of Dubbo LALC in early September 2012 (outside the nominated period for registration).

Section 4.9.4.2 presents the details of Aboriginal community involvement and further consultation during and following field survey.

4.9.4.1.2 Macquarie River Water Pipeline Test Excavations

Following the field survey of the Macquarie River Water Pipeline (see Section 4.9.7.2.1), two potential archaeological deposits (PADs) were identified on the alignment of the proposed water pipeline. OzArk (2013b) identified the need for a test excavation of these PADs. An invitation to attend an Aboriginal Focus Group Meeting (AFGM) to discuss the test excavations was sent to all RAPs on 13 May 2013. The proposed test excavation methodology was sent to the RAPs on 20 May 2013. The AFGM held on 29 May 2013. was attended by Darren Toomey of Dubbo LALC who confirmed the proposed methodology as appropriate. Minutes generated following the AFGM were distributed to all RAPs, however, no feedback on the proposed methodology was received.

Section 4.9.4.2 presents the details of Aboriginal community involvement during the field survey.

4.9.4.2 Aboriginal Community Involvement

The involvement of the Aboriginal community in fieldwork is summarised in **Table 4.61**, which presents the survey dates, survey locations and persons involved.

Table 4.61
Aboriginal Community Involvement in Field Surveys

Survey Date(s)	Aboriginal Representative (of RAP)	Survey Area
22 May 2012	Ashley Hill (WDD), Eric Fernando (BWWHS), Jamie Gray (BWWHS)	DZP Site: Wychitella
23 May 2012	Ashley Hill (WDD), Eric Fernando (BWWHS), Jamie Gray (BWWHS)	DZP Site: "Karingle"
24 and 25 July 2012	Ashley Hill (WDD), Brett Hill (BWWHS), Gary Riley, Jamie Gray (BWWHS)	DZP Site: "Grandale" and "Toongi Valley"
7 and 8 August 2012	Ashley Hill (WDD), Brett Hill (BWWHS), Jamie Gray (BWWHS), Robert Hill (WDD)	DZP Site: "Glen Idol", "Toongi Valley", and "Ugothery"
11 to 13 September 2012	Ashley Hill (WDD), Brett Hill (BWWHS), Michael Toomey	DZP Site: "Pacific Hill" MRWP: "Mia Mia" / Waterline, and Wychitella
18 and 19 October 2012	Brett Hill (BWWHS), Michael Toomey (DLALC), Robert Hill (WDD)	ORA: Obley Road, Rail Bridges, and Wychitella
17 to19 December 2012	Robert Hill (WDD), Ashley Hill (WDD), Jamie Gray (BWWHS), Edward Ryan (DLALC), Terry Toomey (DLALC), Fonua Havili (BWWHS), Tim Stewart (BWWHS), Ray Smith (DLALC)	DZP Site: "Grandale", "Karingle", "Pacific Hill", "Toongi Valley", and "Ugothery"
5 February 2013	Brett Hill (BWWHS) and Malcolm Burns (WDD)	DZP Site: "Karingle" and "Grandale"
25 and 26 June 2013	Malcolm Burns (WDD) and Terry Toomey (DLALC	Test excavations of TS-OS3 and TS-OS5 within the Macquarie River Water Pipeline corridor
MRWP = Macquarie River Water Pipeline ORA = Obley Road Alignment		
Source: Modified after OzArk (2013b) – Table 3		

During the period over which the surveys were undertaken, additional meetings were held and are described as follows.

- A meeting was held on 10 August 2012, to which all RAPs were invited, to discuss the management of the identified and previously recorded sites and obtain any cultural knowledge that may be associated with the DZP Site.
- Following the registration of Dubbo LALC, by Mr Charlie Trindall, an informal meeting was held with representatives from the Applicant, OzArk and Dubbo LALC. The aim of this meeting was to familiarise Dubbo LALC with the Proposal and provide up-to-date information about the assessment process.
- Over the course of the entire fieldwork program, discussions were held on site each day regarding the findings of the field survey. The topics covered included cultural significance, management options and recommendations.
- Following the February 2013 fieldwork, Wirrimbah Direct Descendants submitted a brief report which documented the result of this one day assessment.
- During the course of the field survey, Coral Peckham of WDD raised a request to hold a meeting with the Applicant and OzArk to discuss the cultural heritage values and proposed management of identified sites. This request was agreed to by the Applicant, however, it was determined that the meeting be scheduled to follow the completion of two test excavations along the alignment of the Macquarie River Water Pipeline corridor (refer to Sections 4.9.4.1.5 and 4.9.7.2.2) and finalisation of the assessment phase of OzArk (2013b).

It was agreed by all Aboriginal stakeholders present during the heritage surveys that the cultural significance and the management of each archaeological site identified would be included in an archaeological report to be prepared by OzArk. In June 2013, a draft version of the Aboriginal Heritage Assessment was distributed to all RAPs with an invitation extended to attend an AFGM meeting to discuss the document, and in particular, the results of the surveys and management recommendations.

The AFGM was held on 13 August 2013 and was attended by Darren Toomey and Willie Carr (of DLALC), and Ray Smith and Geoff Ryan (of WDD). Apologies were received from Jamie Gray and Dot Stewart (of BWWHS), and Diane Stewart. The AFGM included an inspection of a number of sites that would be impacted and discussion as to cultural values and management of the various sites. Potential for future employment of Aboriginal people was also discussed.

A revised Aboriginal Heritage Assessment, incorporating the results of discussions completed during the AFGM, was distributed to the RAPs on 19 August 2013. Feedback was received from all RAPs between 20 August and 22 August 2013.

- WDD: Geoff Ryan approved of the report and the minutes of the recent AFGM.
- BWWHS and Diane Stewart: Requested inclusion in the formation of the Care Agreement to clarify the destination of the objects salvaged from impacted sites. A proposal to relocate salvaged items to Wiradjuri Park and exhibit with a plaque and aerial photograph was nominated.
- Dubbo LALC: Darren Toomey approved of the report and the minutes of the recent AFGM.

OzArk (2013b) provides further details on the specific feedback received from the RAPs.

4.9.5 Background Research and Literature Review

4.9.5.1 Regional Archaeological Context

The Dubbo locality lies within the northern limits of Wiradjuri country, as defined by the limits of the Wiradjuri language group. Bordering to the west is Wongaibon country, and to the north Kawanbarai country. Dubbo City itself lies within the traditional territory of the Dubba-ga (Thubba-ga) people who were part of the broader Wiradjuri tribe and were thought to have comprised of groups of approximately 30 to 40 people. The territory of these people generally lies to the east of the Macquarie River, south of the Talbragar River and north of Eulomogo Creek, although, there is some conjecture that the group inhabited both sides of the Macquarie River.

Patterns of Aboriginal and early European settlement in the region (of Dubbo and surrounds) have been analysed as part of broad regional studies (Koettig, 1985; Balme, 1986). Based on these analyses, Koettig (1985) makes the following conclusions with regard to the Aboriginal occupation of the region.

- Evidence of Aboriginal occupation may be expected throughout all landscape units, with the most frequently occurring examples of occupation being open artefact scatters, scarred trees and grinding grooves.
- Aboriginal occupation of specific areas within the region would be determined by various factors, predominantly environmental and social. Although social factors cannot be explained through archaeological research, some of the environmental issues may be. These are as follows.
  - Proximity to water - the largest camp sites were located close to permanent water.
  - Geological formation - certain sites require specific conditions, e.g. grinding grooves occur where appropriate sandstone outcrops.
  - Availability of food resources - the widest range of potential foods was found along the main water courses due to the supply of permanent water.

Koettig (1985) suggested that larger and more constantly occupied sites are likely to occur along permanent watercourses, while less intense and sporadic occupation evidence is seen along ridge tops or temporary water sources e.g. creek headwaters.

4.9.5.2 Local Archaeological Context

OzArk (2013b) records that Lloyd Nolan (2000) states that the Toongi locality is within the ‘Dundullimal’ territory, a sub group of the Thubba Gah-Wiradjuri nation. “The Springs” property (Heritage listed with local significance), approximately 4km south of the DZP Site, is a location of early contact between Aboriginal and European people in the Dubbo region. It is likely that Aboriginal people remained active in the vicinity of Toongi into the historical period with many being employed by local landowners as station-hands and/or helpers.

A review of the past and present land use patterns within the Toongi locality demonstrates that substantial parts of the landscape, especially along flats and low slopes (particularly associated with creek lines) have undergone significant physical modification as a result of agricultural activities, particularly cropping, grazing and alteration of pre-European fire regimes.

These activities have disturbed or destroyed ecological niches that may have been located in the resource rich creek areas in prehistory. Other processes have also been responsible for the modification/destruction of the environment, including increased erosion and soil movement as a result of white and black cypress pine monocultures and tree removal as well as the altered hydrological impacts of flooding, both of which may have contributed to the disturbance and/or redistribution of topsoils.

4.9.5.3 Local Archaeological Record

Significant sites that are registered in the Toongi – Dubbo locality include the following.

- Indigenous Place at 'Brocklehurst' – bora ground (Australian Heritage Database/ Register of the National Estate)
- Indigenous Place at 'Toongi Valley' – carved tree (Australian Heritage Database/ Register of the National Estate)
- The 'Springs' at Toongi – while the significance of this Australian Heritage Database listing is based primarily on historic occupation, it is noted that the place is also important for its relationship to Aboriginal and early settler contact (NSW Heritage, 2012).
- Dundullimal Homestead near Dubbo – while the significance of this Australian Heritage Database listing is based on historic occupation and not Aboriginal occupation, it is included here as there is a known extensive Aboriginal site located on the property, Aboriginal people were employed there in 1891 (NSW Heritage 2012b), and there is an ethnographic report of a corroboree held there is the 1840s, attended by 600-800 people (OzArk 2006: 33). The Aboriginal site located on the "Dundullimal" property is reported to have had Aboriginal ceremony and dreaming components, a ceremonial ring, a hearth, grinding grooves, and artefacts associated with an open camp site/ artefact scatter (AHIMS site #36-1-0021).

OzArk (2013b) identified that previous Aboriginal heritage assessments have been undertaken within the locality of the DZP Site as follows.

i) In 2000, Mr Lloyd Nolan undertook a survey of 6ha which overlaps the current open cut impact footprint for resource drilling related to the current Proposal. Two Aboriginal sites were recorded during this assessment, namely, an isolated artefact and a grinding groove site, respectively (see **Figure 4.38**).

ii) In 2002, Mr Lloyd Nolan undertook an assessment for an earlier version of the DZP Proposal. As a result of his assessment, 22 Aboriginal sites were recorded with 11 scarred trees, six open artefact scatters, three grinding groove sites and two isolated artefacts (see **Figure 4.38**).

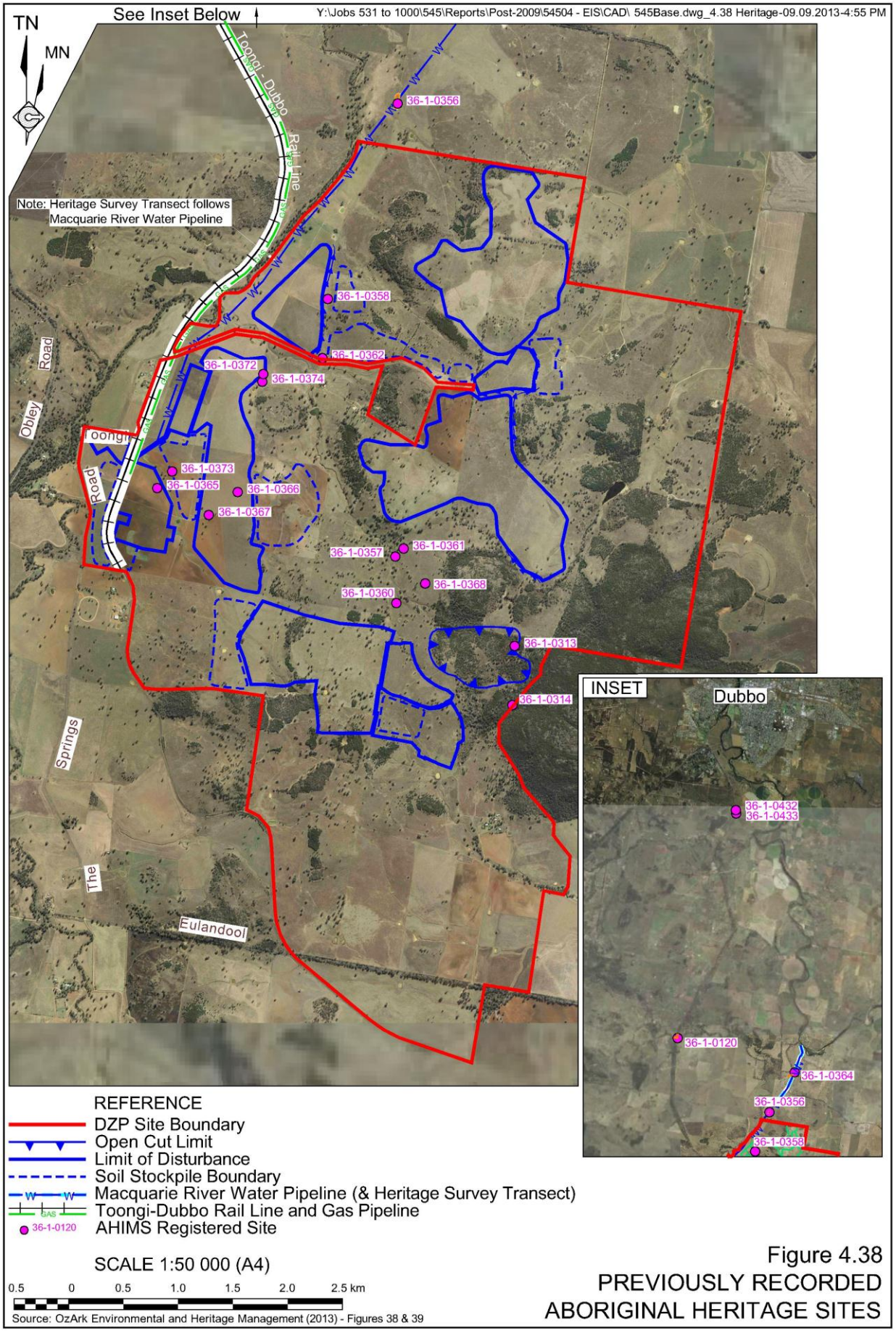


Figure 4.38
PREVIOUSLY RECORDED
ABORIGINAL HERITAGE SITES

iii) Other assessments have been undertaken over the years on Obley Road, primarily for environmental impact assessments for road alignment projects. Kelton (1997), Nolan (2000), OzArk (2003) as well as amateur archaeologist Warren Bluff, among others, contributed to the recorded total of 33 AHIMS-listed sites on the edges of Obley Road between the DZP Site and town of Dubbo. The overwhelming majority of these sites are scarred trees.

No previous assessments have been undertaken within the impact footprint of the Toongi – Dubbo Rail Line.

Table 4.62 and **Figure 4.38** present the 19 previously recorded Aboriginal heritage registered AHIMS sites that have been recorded within or adjacent to the component disturbance areas of the Proposal.

Table 4.62
Registered AHIMS Sites

Site Number	Description	Landform
DZP Site		
36-1-0373 (TS-ST-03)	Aboriginal scarred tree with no associated artefacts. Scar has closed since its initial recording in 2002	Gently Undulating
36-1-0365 (TS-ST-04)	Aboriginal scarred tree with no associated artefacts	Gently Undulating
36-1-0366 (TS-ST-05)	Aboriginal scarred tree with no associated artefacts. Scar has closed slightly since it initial recording in 2002	Gently Undulating
36-1-0367 (TS-ST-06)	Aboriginal scarred tree with no associated artefacts	Gently Undulating
36-1-0368 (TS-ST-07)	Aboriginal scarred tree with no associated artefacts	Gently Undulating
36-1-0313 (TS-IF-01)	Isolated artefact. Original artefacts of a chert flake could not be located however, a new artefact of pinkish chert piece of flake shatter was recorded	Gently Undulating
36-1-0314 (TS-GG-01)	Grinding grooves located adjacent, however, outside the impact footprint	Creek
36-1-0374 (TS-ST-01)	Aboriginal scarred tree with the scar almost completely closed. Scar was located very low to the ground and was questionable if it was of Aboriginal origin	Gently Undulating
36-1-0372 (TS-ST-02)	Aboriginal scarred tree with the scar almost completely closed. Scar was not uniform in shape and very low to the ground and was questionable if it was of Aboriginal origin	Gently Undulating
36-1-0357 (TS-OS-01 with PAD)	Artefact scatter with a new recording of possible grinding grooves	Floodplain
36-1-0361 (TS-GG-02 with PAD)	Grinding grooves with several new grooves identified	Creek/ Floodplain
36-1-0360 (TS-GG-03)	Grinding grooves	Floodplain
36-1-0358 (TS-OS-02)	Artefact scatter could not be located and may have been destroyed by vehicle movement	Gently Undulating
36-1-0362 (TS-IF-02)	Isolated artefact of orange chalcedony flake	Gently Undulating
Obley Road Realignment		
36-1-0432 (ORWM-ST1)	Aboriginal scarred tree	Gently Undulating
36-1-0433 (ORWM-ST2)	Aboriginal scarred tree	Gently Undulating
36-1-0120 (H2 with PAD)	Aboriginal scarred tree and artefact scatter	Floodplain
Macquarie Water Pipeline Area		
36-1-0356 (TS-OS-03 with PAD)	Artefact scatter	Floodplain
36-1-0364 (TS-OS-05 with PAD)	Artefact scatter	Floodplain
Source: Modified after OzArk (2013) – Table 9		

4.9.6 Predictive Model

Predictive modelling aims to establish a theoretical model for site location and distribution within a given area. The predictive model considers proximity to permanent water, availability of resources for shelter and tool making, and availability of food. Based on these factors, archaeological context and the landform potential, OzArk (2013b) makes the following predictions in relation to the nature of sites and their potential location within the study areas.

- Open sites may be found on elevated terraces and low spurs close to water such as Wambangalang Creek. These sites may be complex and/or extensive.
- Scarred trees are frequently found close to creeks and rivers but also found further afield. Most of the old-growth woodlands have been removed from the landscape, although some isolated old-growth trees which may bear scars occur in the cleared paddocks and along the drainage lines, as well as along the road corridor of Obley Road.
- Natural mythological or cultural/ceremonial sites may occur anywhere.
- Shelter sites with art and/or deposit may occur wherever there are appropriate sandstone overhangs. The Study Area does not contain escarpments, and the only locality within the Study Area with potential for suitable rocky overhangs is on the "Glen Idol" property (proposed open cut).
- Grinding groove sites would only occur where there are appropriate outcropping sandstone formations, usually near water, and therefore may be found near any of the waterways in the study areas.
- Isolated finds may occur anywhere, especially in disturbed locations near water sources or in areas close to ephemeral water, i.e. headwaters.

4.9.7 Field Survey Methodology and Results

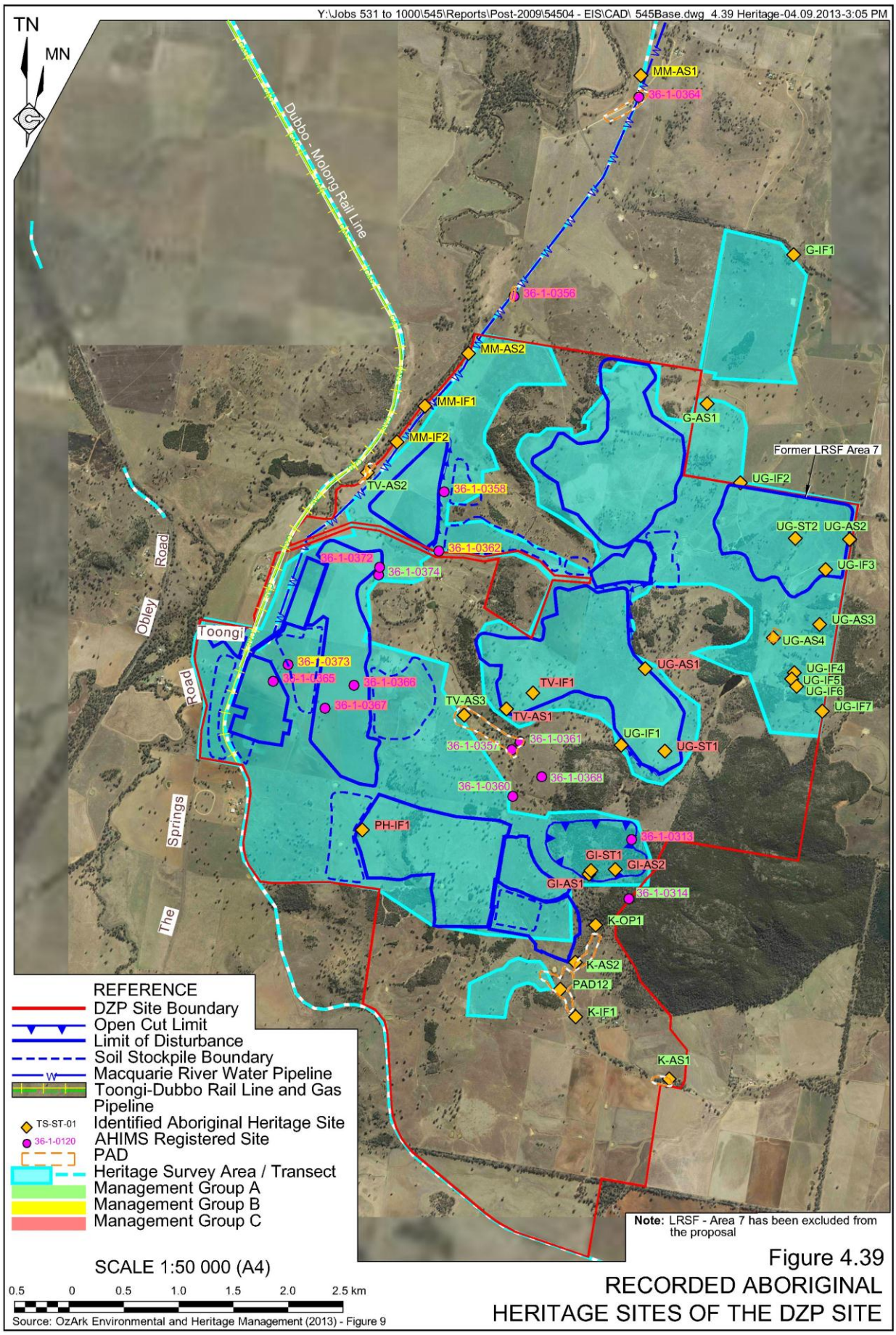
4.9.7.1 Methodology

4.9.7.1.1 Overview

Separate field surveys were conducted for the four study areas (see Section 4.9.2) with coverage displayed on **Figures 4.39** to **4.41**. Details of the survey dates and locations are provided in **Table 4.61**. During the field surveys, discussions were held on site regarding the findings of the field survey and the topics covered included cultural significance, management options and recommendations.

4.9.7.1.2 DZP Site Study Area

The DZP Site study area was surveyed with a combination of pedestrian transects and spot checks. Transects were walked at variously spaced intervals, dependent on ground visibility and archaeological potential. These intervals ranged from 5m distance in areas with narrow impact zones, to approximately 20m intervals in areas with moderate potential for site occurrence.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TN
MN
Dubbo - Molong Rail Line
MM-AS1
36-1-0364
G-IF1
36-1-0356
MM-AS2
MM-IF1
MM-IF2
G-AS1
Former LRSF Area 7
TV-AS2
36-1-0358
UG-IF2
UG-ST2
UG-AS2
36-1-0362
36-1-0372
36-1-0374
UG-IF3
Obley Road
Toongi
UG-AS3
UG-AS4
36-1-0373
36-1-0365
36-1-0366
UG-AS1
UG-IF4
UG-IF5
UG-IF6
TV-IF1
TV-AS3
36-1-0367
TV-AS1
UG-IF7
36-1-0361
UG-IF1
36-1-0357
UG-ST1
36-1-0368
36-1-0360
Springs Road
PH-IF1
36-1-0313
GI-ST1
GI-AS2
GI-AS1
36-1-0314
The
K-OP1
K-AS2
PAD12
K-IF1
K-AS1
REFERENCE
DZP Site Boundary
Open Cut Limit
Limit of Disturbance
Soil Stockpile Boundary
Macquarie River Water Pipeline
Toongi-Dubbo Rail Line and Gas Pipeline
TS-ST-01 Identified Aboriginal Heritage Site
36-1-0120 AHIMS Registered Site
PAD
Heritage Survey Area / Transect
Management Group A
Management Group B
Management Group C
Note: LRSF - Area 7 has been excluded from the proposal
SCALE 1:50 000 (A4)
0.5 0 0.5 1.0 1.5 2.0 2.5 km
Source: OzArk Environmental and Heritage Management (2013) - Figure 9
Figure 4.39
RECORDED ABORIGINAL HERITAGE SITES OF THE DZP SITE

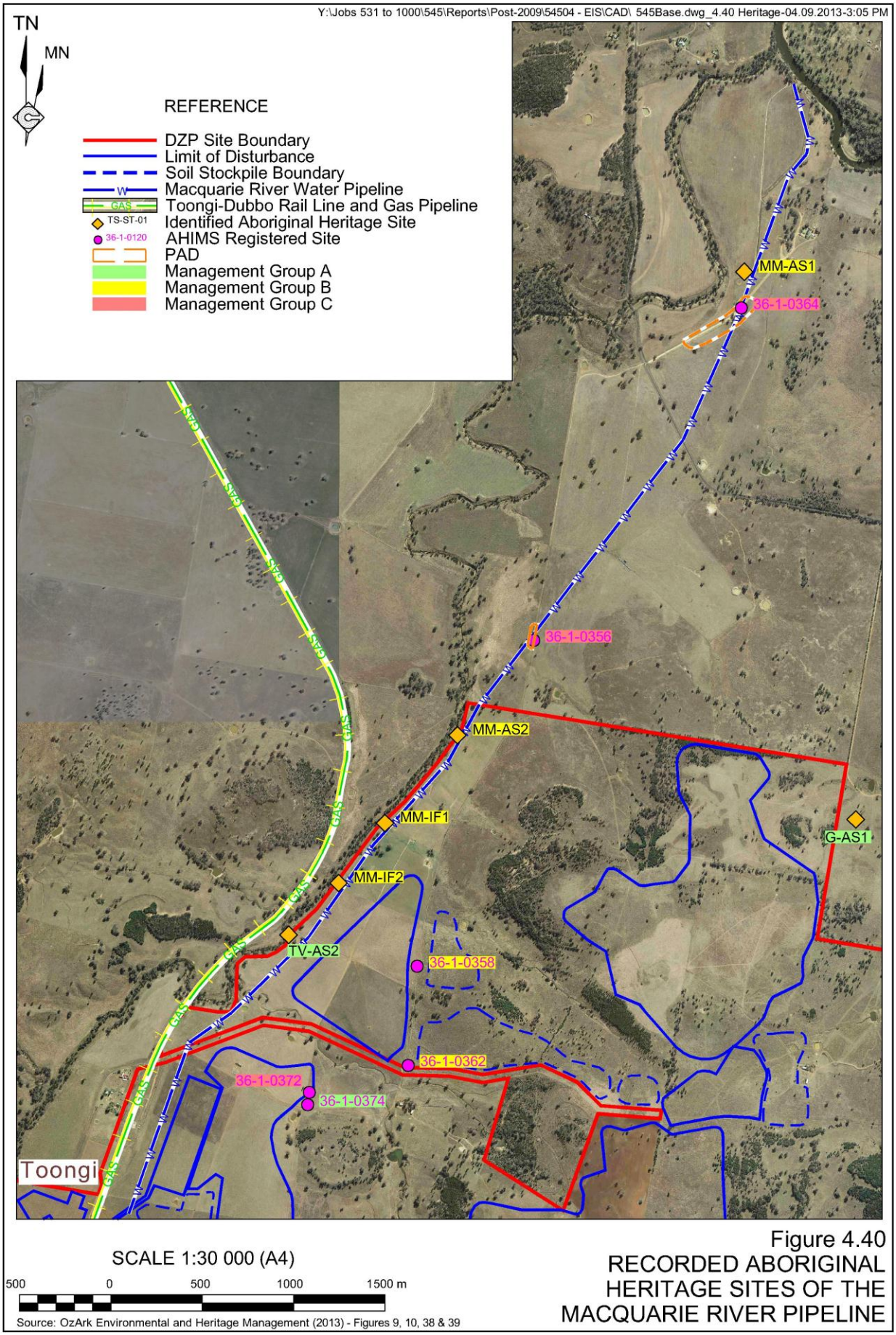

Figure 4.40
RECORDED ABORIGINAL HERITAGE SITES OF THE MACQUARIE RIVER PIPELINE

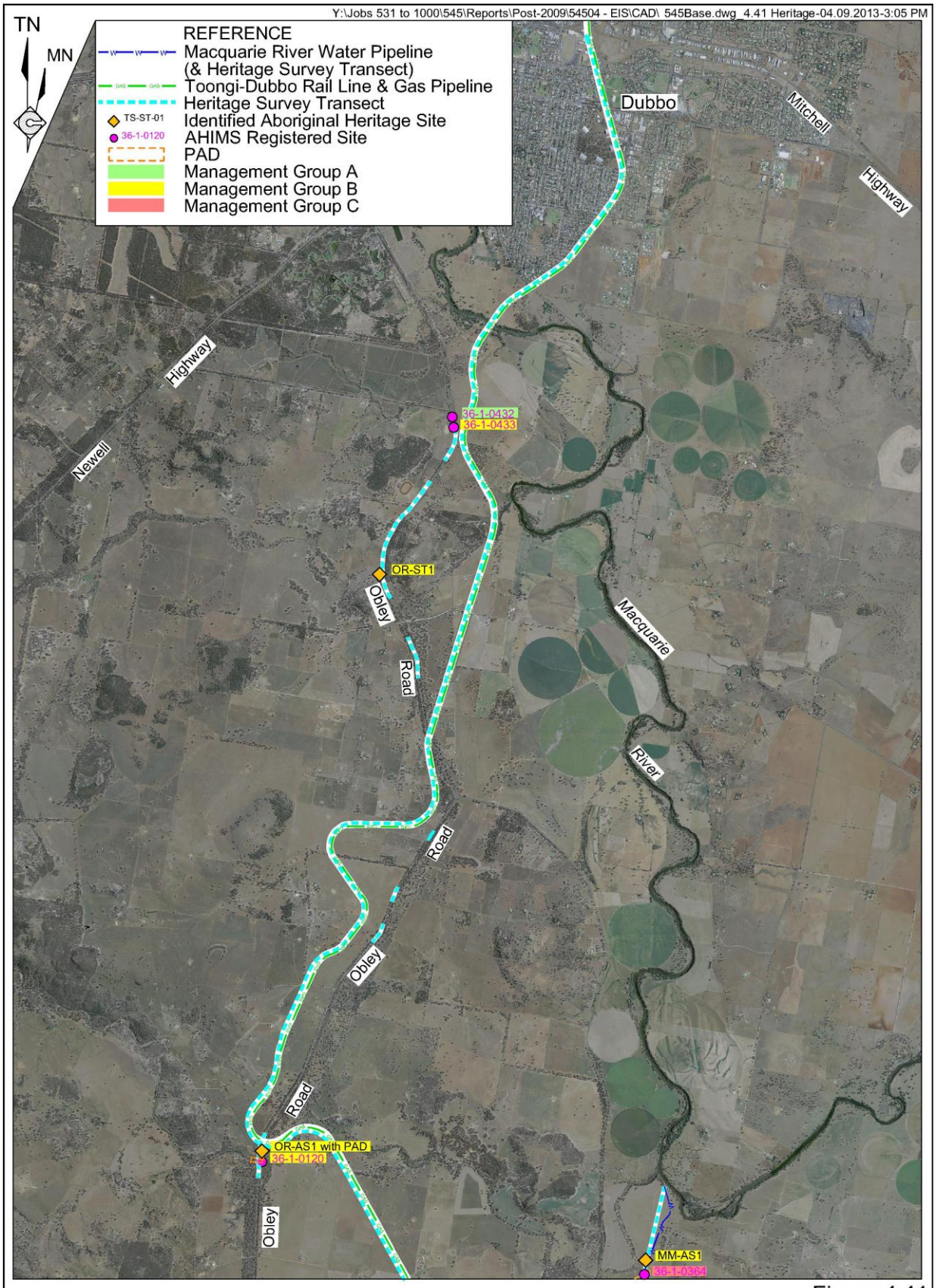

Figure 4.41
RECORDED ABORIGINAL HERITAGE SITES OF THE TOONGI-DUBBO RAIL LINE AND OBLEY ROAD

Areas with high potential for archaeological sites were targeted by implementing more closely spaced transects. Areas that were more closely examined consist of terraces adjacent to creeks and the creeks themselves, and areas of exposure, such as road cuts and areas of erosion. All trees old enough to bear scars of Aboriginal origin were inspected with rocky outcrops examined for grinding grooves.

Cleared paddocks were surveyed with wider transects. When ground visibility was zero, pedestrian transects were abandoned in favour of vehicle transects with spot checks at exposures and old-growth trees capable of bearing scars of Aboriginal origin.

Cropped paddocks having a negligible likelihood of revealing open sites were not surveyed due to the following limitations.

- Paddocks had been recently ploughed.
- Paddocks were cropped and access was not possible.
- Zero ground visibility due to high grasses.

4.9.7.1.3 Macquarie Water Pipeline and Obley Road Alignment

Obley Road Alignment and Macquarie Water Pipeline impact footprints were surveyed to approximately 20m from the centreline of the road or pipeline corridor or if restricted to private property boundary fences.

4.9.7.1.4 Toongi-Dubbo Rail Line

Each of the Toongi-Dubbo Rail Line crossing upgrade locations were inspected and pedestrian surveys completed.

4.9.7.1.5 Macquarie River Water Pipeline Test Excavations

The primary objectives of the test excavations were to:

- assess the nature, extent and integrity of two PADs that occur within the Macquarie River Water Pipeline corridor (TS-OS-03 with PAD and TS-OS-05 with PAD – refer to Section 4.9.7.2.1); and
- inform further management of the sites (such as the possibility of salvage excavation).

Appendix 7 of OzArk (2013b) provides a detailed description of the methodology for the test excavations which is summarised broadly as follows.

- Transects were excavated through the PADs, intersecting areas displaying greater concentrations of artefacts.
- Representative sample of artefacts were retrieved to characterise each PAD in terms of raw material utilisation, use of particular artefacts, the presence or otherwise of stone tool manufacture, and methods of subsistence employed.
- Provision to expand around areas of higher artefact density or notable features was included.

4.9.7.2 Survey Results

4.9.7.2.1 General Survey of the Application Area

The combined field surveys undertaken by OzArk and RAPs resulted in 52 sites being identified within the DZP Site, Toongi-Dubbo Rail Line and Obley Road Realignment Study Areas. These sites include 19 sites previously recorded on the AHIMS database.

Each of the newly identified sites have been either assigned a prefix representing the relevant property name "UG" (Ugothery), "K" (Karingle), "GI" (Glen Idol), "PH" (Pacific Hill), "TV" (Toongi Valley) or "G" (Grandale) or "MM" in the case of the Macquarie River Water Pipeline Study Area and "OR" in the case of the Obley Road Realignment Study Area. These are then followed by a sub-prefix of either AS (Lithic Scatter), IF (Isolated Find), ST (Scarred Tree), OP (Ochre Processing Area) or PAD (Potential Archaeological Deposit) by OzArk, (2013b).

Figures 4.39 to **4.41** display the locations of all sites identified by OzArk throughout the field surveys, together with the 19 AHIMS registered sites. **Table 4.63** provides a brief description of each of the newly recorded sites (see *Section 5.3* of OzArk, 2013b for more detailed descriptions) and **Table 4.64** provides a brief description of each of the re-recorded AHIMS registered sites (see *Section 5.4* of OzArk, 2013b for more detailed descriptions).

Table 4.63
Recorded Aboriginal Heritage Sites

Page 1 of 2

Site Reference	Description	Landform Context
DZP Site		
UG-AS1	Lithic scatter consisting of flakes and flake shatter	Gently undulating in a ploughed paddock near a farm dam with sub-surface deposits unlikely
UG-AS2	Lithic scatter consisting of four flakes covering an area of 50m x 5m	Floodplain in a vehicle track exposure with subsurface with sub-surface deposits unlikely due to the impacts to the area
UG-AS3	Lithic scatter consisting of broken axe head, hammerstone and three flakes with 80m x 5-10m area	Gently undulating with subsurface deposits unlikely due to the artefacts being moved by past erosion and agricultural impacts
UG-AS4	Lithic scatter consisting of care and seven flakes over a 45m x 10m area	Gently undulating adjacent to a 2nd order stream
UG-ST1	Scarred tree with scar 80cm x 13cm oblong shape approximately 30cm from base of tree and oriented to the southwest	Gently undulating with a single box eucalypt tree in a cleared paddock
UG-ST2	Scarred tree with scar approximately 75cm x 35cm elongated shape approximately 105cm above the ground with 1-2 axe marks and oriented to the north	Gently undulating and approximately 50m of large ephemeral drainage course
UG-IF1	Isolated lithic artefact consisting of a tertiary flake	Floodplain, gently undulating
UG-IF2	Isolated lithic artefact consisting of a flake of uncertain material possibly rhyolite	Gently undulating northeast of a prominent unnamed hill and in a small drainage line
UG-IF3	Isolated lithic artefact consisting of a single hammerstone	Floodplain and due to impacts by agriculture it is unlikely that intact subsurface deposits would be present
UG-IF4	Isolated lithic artefact consisting of a large basal flake	Gently undulating within an erosion exposure disturbed by land clearing
UG-IF5	Isolated lithic artefact consisting of a quartz flaked piece	Gently undulating in an erosion exposure disturbed by land clearing activities
UG-IF6	Isolated lithic artefact consisting of a tertiary mudstone flake	Gently undulating within an exposure with agricultural disturbances present in the area

Table 4.63 (Cont'd)
Recorded Aboriginal Heritage Sites

Site Reference	Description	Landform Context
DZP Site (Cont'd)		
UG-IF7	Isolated lithic artefact consisting of quartz tertiary flake	Gently undulating within an erosion exposure and vehicle track with subsurface deposits unlikely
K-AS1 with PAD	Lithic scatter consisting of ten lithic artefacts covering an area approximately 15m x 10m	Gently undulating adjacent to Cockabroo Creek
K-AS2 with PAD	Lithic scatter consisting of several flakes and a scarred tree	Floodplain and watercourse impacted by agricultural activities
K-OP1	Ochre processing area consisting of a small mound of multi-coloured pigmented clay measuring approximately 1m x 1m.	Floodplain within gently undulating with unknown provenance
K-IF1	Isolated lithic artefact consisting of a silcrete secondary flake	Floodplain adjacent to dry watercourse
PAD 12	Potential archaeological deposit, no sites could not be located in this area however visibility was poor	Floodplain adjacent to a dry watercourse with occasional water pooling
GI-AS1	Lithic scatter consisting of two artefacts	Gently undulating adjacent to a third order water course
GI-AS2	Lithic scatter consisting of two lithic artefacts	Gently undulating on skeletal soils impacted by erosion and recreational activities
PH-IF1	Isolated lithic artefact consisting of a chert flake	Gently undulating, adjacent to ephemeral creek impacted by vehicle track and agricultural activities
TV-AS1	Lithic scatter consisting of two artefacts	Gently undulating impacted by agricultural activities with sub-surface deposits unlikely
TV-AS2 with PAD	Lithic scatter consisting of six artefact adjacent to Wambangalang Creek with extent unknown	Floodplain not inside impact foot print
TV-AS3 with PAD	Lithic scatter consisting of core, flakes and grinding stone with a density of four per square metre	Floodplain, gently undulating and adjacent to a 2nd order watercourse
TV-IF1	Isolated lithic artefact consisting of a flake	Gently undulating impacted by agricultural activities with sub-surface deposits are unlikely
G-AS1	Lithic scatter consisting of two artefacts	Gently undulating with moderate erosion impacted by agricultural activities and unlikely sub-surface deposits
G-IF1	Isolated lithic artefact consisting of a single quartz flake	Gently undulating impacted by agricultural activities
Toongi-Dubbo Rail Line		
No Aboriginal sites have been recorded in the impact zone for the Toongi-Dubbo Rail Line in the areas assessed.		
Macquarie Water Pipeline		
MM-AS1	Lithic scatter consisting of 11 artefacts of flake and flake shatter	Floodplain heavily impacted by agricultural activities
MM-AS2	Lithic scatter consisting of four artefacts of flakes and cores	Floodplain on the edge of heavily impacted agricultural land
MM-IF1	Isolated lithic artefact either a test cobble or lightly used core	Floodplain impacted by agricultural activities
MM-IF2	Isolated lithic artefact consisting of a core	Floodplain heavily impacted by agricultural activities with sub-surface deposits unlikely
Obley Road Alignment		
OR-AS1 with PAD	Lithic scatter of three artefacts consisting of core and flakes	Floodplain adjacent to Hyandra Creek
OR-ST1	Scarred tree with a scar length of 172cm x 70cm, oriented to the south-southeast and approximately 34cm from the ground	Floodplain and unlikely sub-surface deposits
Source: Modified after OzArk (2013) – Table 8		

Table 4.64
Re-recorded AHIMS Registered Sites

Site Reference	Description	Landform Context
DZP Site		
#36-1-0373 (TS-ST-03)	Aboriginal scarred tree	gently undulating
#36-1-0365 (TS-ST-04)	Aboriginal scarred tree	gently undulating
#36-1-0366 (TS-ST-05)	Aboriginal scarred tree	gently undulating
#36-1-0367 (TS-ST-06)	Aboriginal scarred tree	gently undulating
#36-1-0368 (TS-ST-07)	Aboriginal scarred tree	gently undulating
#36-1-0313 (TS-IF-01)	Isolated artefact	gently undulating
#36-1-0314 (TS-GG-01)	Grinding grooves	Creek
#36-1-0374 (TS-ST-01)	Aboriginal scarred tree	gently undulating
#36-1-0372 (TS-ST-02)	Aboriginal scarred tree	gently undulating
#36-1-0357 (TS-OS-01 with PAD)	Artefact scatter	floodplain
#36-1-0361 (TS-GG-02 with PAD)	Grinding grooves	creek/ floodplain
#36-1-0360 (TS-GG-03)	Grinding grooves	floodplain
#36-1-0358 (TS-OS-02)	Artefact scatter	gently undulating
#36-1-0362 (TS-IF-02)	Isolated artefact	gently undulating
Macquarie River Water Pipeline		
#36-1-0356 (TS-OS-03 with PAD)	MM-6	floodplain
#36-1-0364 (TS-OS-05 with PAD)	MM-2	floodplain
Obley Road Alignment		
#36-1-0432 (ORWM-ST1)	Aboriginal scarred tree	gently undulating
#36-1-0433 (ORWM-ST2)	Aboriginal scarred tree	gently undulating
#36-1-0120 (H2 with PAD)	Aboriginal scarred tree and artefact scatter	floodplain
Source: Modified after OzArk (2013b) – Table 9		

4.9.7.2.2 Macquarie River Water Pipeline Test Excavations

Five artefacts were retrieved at site TS-OS-03 with PAD, however, no subsurface artefacts were recorded at TS-OS-05 with PAD. OzArk (2013b) conclude that the lack of artefacts has been influenced by local disturbance such as ploughing, flooding and stock/vehicle movements. As a result the landforms are degrading and artefacts are not being buried by natural deposition of soils.

4.9.7.3 Potential Impacts

4.9.7.3.1 Impacted Sites

During the planning process for the Proposal, modifications to the layout of various features were made based on the identification and potential impact on Aboriginal sites (including Potential Archaeological Deposits [PADs]). Following the implementation of efforts to avoid direct impact on the identified sites, potential impact on Aboriginal heritage has been reduced as follows.

- 26 sites are outside the impact footprint of the Proposal.

- 12 sites are located adjacent to the impact footprint of the Proposal and would require careful management in order to avoid indirect impacts.
- 14 sites occur either partially or completely within the impact footprint.

4.9.7.3.2 Significance of Sites

The NSW Office of Environment and Heritage policy is to safeguard all sites, Aboriginal places and archaeological material of significance, wherever possible. This requires that some means of assessing the significance of the sites is necessary. The significance of a site can be assessed in the following five ways.

- Cultural / Social significance: the importance of a site to the relevant cultural group, in this case the Aboriginal community.
- Aesthetic significance: the aspects of sensory perception which can demonstrate the cultural setting for a site.
- Public significance: the importance of a site to educate people about the past.
- Historic significance: encompasses the history of aesthetics, science and society, and therefore to a large extent underlies all other values.
- Scientific significance: the importance of a site in view of current archaeological discourse based on a site's condition (integrity), content and representativeness.

OzArk (2013b) reviewed the relative significance of the sites identified, a summary of which is as follows.

Social or Cultural Significance

The social or cultural value of Aboriginal sites is generally determined through consultation with Aboriginal people. Generally considered, however, any site recorded is likely to be reflective of the widespread use of the land by Aboriginal people over time. The sites provide a tangible, continued cultural connection with the land, and have elevated importance due to the diminishing knowledge of Aboriginal culture since white settlement. In this way, all sites have some level of cultural value.

Throughout the field investigations, as well as during the AFGM conducted to review the proposed management of sites, cultural values were discussed with the RAPs. It was noted by the RAPs that the variety of site types present reflect the range of ways the landscape was used by Aboriginal people. A result of the AFGM was to attribute a moderate social/cultural value to all sites.

Aesthetic Significance

None of the Aboriginal sites recorded have significant aesthetic value as the integrity of the sensory landscape has been altered in historic and modern times. Additionally, the artefacts themselves are generally not remarkable and have been assessed as holding low aesthetic value.

Historic Significance

None of the Aboriginal sites recorded have an apparent direct relationship to known historical Aboriginal sites such as missions or massacre sites. It is likely that the area saw some of the earliest contact between Aboriginals and non-Aboriginal settlers, however, none of the recorded Aboriginal sites display evidence that they constitute 'Contact' or 'Post-Contact' Aboriginal sites. To that end, all are assessed as holding low historic value.

Scientific Significance

Of the 52 identified Aboriginal sites, OzArk (2013b) assigned the following scientific values (see also **Table 4.65**).

- 36 are of low value.
- 5 are of low-moderate value.
- 9 are of moderate value.
- 2 are of moderate-high value.

4.9.7.3.3 Summary of Impacts and Significance

Figures 4.39 to **4.41** identify the location of each of the sites and **Table 4.65** summarises the potential impact.

Table 4.65
Potential Impacts and Significance of Aboriginal Sites

Page 1 of 2

Reference	Potential Impact	Significance (Scientific)
Impact Avoided		
UG-AS2	No potential impact	No loss of value
UG-AS3	No potential impact	No loss of value
UG-AS4	No potential impact	No loss of value
UG-ST2	No potential impact	No loss of value
UG-IF1	No potential impact	No loss of value
UG-IF2	No potential impact	No loss of value
UG-IF3	No potential impact	No loss of value
UG-IF4	No potential impact	No loss of value
UG-IF5	No potential impact	No loss of value
UG-IF6	No potential impact	No loss of value
UG-IF7	No potential impact	No loss of value
K-AS1 with PAD	No potential impact	No loss of value
K-AS2 with PAD	No potential impact	No loss of value
K-IF1	No potential impact	No loss of value
K-OP1	No potential impact	No loss of value
PAD 12	No potential impact	No loss of value
TV-AS2 with PAD	No potential impact	No loss of value
TV-AS3 with PAD	No potential impact	No loss of value
GI-IF1	No potential impact	No loss of value
36-1-0368 (TS-ST-07)	No potential impact	No loss of value

Table 4.65 (Cont'd)
Potential Impacts and Significance of Aboriginal Sites

Reference	Potential Impact	Significance
Impact Avoided (Cont'd)		
36-1-0374 (TS-ST-01)	No potential impact	No loss of value
36-1-0357 (TS-OS-01 with PAD)	No potential impact	No loss of value
36-1-0361 (TS-GG-02 with PAD)	No potential impact	No loss of value
36-1-0360 (TS-GG-03)	No potential impact	No loss of value
36-1-0432 (OR-WM-ST1)	No potential impact	No loss of value
Direct Impacts		
UG-AS1	Liquid Residue Storage Facility	Low-Moderate scientific value
UG-ST1	Liquid Residue Storage Facility	Low scientific value
GI-AS1	Open Cut	Low scientific value
GI-AS2	Open Cut	Low scientific value
GI-ST1	Open Cut	Low scientific value
PH-IF1	Solid Residue Storage Facility	Low scientific value
TV-AS1	Liquid Residue Storage Facility	Low scientific value
TV-IF1	Liquid Residue Storage Facility	Low scientific value
36-1-0365 (TS-ST-04)	Processing Plant and Administration Area	Low scientific value
36-1-0366 (TS-ST-05)	Liquid Residue Storage Facility	Low scientific value
36-1-0367 (TS-ST-06)	Liquid Residue Storage Facility	Low scientific value
36-1-0372 (TS-ST-02)	Liquid Residue Storage Facility	Low scientific value
36-1-0313 (TS-IF-01)	Open Cut	Low scientific value
36-1-0356 (TS-OS-03 with PAD)	Defined PAD traversed by the Macquarie River Water Pipeline	Partial loss of value. Moderate scientific value
36-1-0364 (TS-OS-05 with PAD)	Defined PAD traversed by the Macquarie River Water Pipeline	Partial loss of value. Moderate scientific value
Adjacent to Impact Footprint (Management Required)		
OR-AS1 with PAD	Obley Road Realignment	Moderate scientific value
MM-AS 1	Adjacent to Macquarie River Water Pipeline	Low scientific value
MM-AS2	Adjacent to Macquarie River Water Pipeline	Low scientific value
MM-IF1	Adjacent to Macquarie River Water Pipeline	Low scientific value
MM-IF2	Adjacent to Macquarie River Water Pipeline	Low scientific value
36-1-0373 (TS-ST-03)	Between processing plant and soil stockpile area	Low scientific value
36-1-0314 (TS-GG-01)	Adjacent to Open Cut	Moderate scientific value
36-1-0358 (TS-OS-02)	Adjacent to Liquid Residue Storage Facility – Area 2	Low scientific value
36-1-0362 (TS-IF-02)	Adjacent to Liquid Residue Storage Facility – Area 2	Low scientific value
36-1-0433 (OR-WM-ST2)	Close to road realignment, however, can be avoided with management measures	Low scientific value
OR-ST1	Within Obley Road easement.	Low scientific value
36-1-0120 (H2 with PAD)	Within Obley Road easement	Moderate scientific value
Source: Modified after OzArk (2013b) – Table 13		

4.9.8 Management and Mitigation Measures

4.9.8.1 Introduction

Recognising the relatively large impact footprint of the Proposal, the Applicant has followed the principles of 'avoid, minimise, mitigate' to reduce the impact of the Proposal on local heritage values.

4.9.8.2 Avoid Impact

The site of the proposed processing operations and related infrastructure has been located over land which has been regularly cultivated over many years. The areas targeted for the positioning of disturbance associated with the management of waste rock and residues generated by the mining and processing operations considered local environmental considerations and heritage values with efforts made to exclude the following areas with higher archaeological potential.

- The remnant vegetation of Dowds Hill.
- Larger and intact remnants of native woodland vegetation.
- Major drainage lines.

In developing the initial impact footprint, the Applicant noted the locations of previously-identified Aboriginal sites and attempted to avoid these where practical. Seven sites, those being, 36-1-0358 (TS-OS-02), 36-1-0362 (TS-IF-02), 36-1-0374 (TS-ST-01), 36-1-0360 (TS-GG-03), 36-1-0357 (TS-OS-01 with PAD), 36-1-0361 (TS-GG-02 with PAD) and 36-1-0314 (TS-GG-01) were specifically identified and the relevant impact area modified as required to avoid.

The survey of the initially-designed impact footprint yielded a number of new sites. Following considerations of these sites and environmental factors, sixteen of the newly-recorded sites were excluded in the re-design of the impact footprint. These were UG-AS2, UG-AS3, UG-AS4, UG-ST2, UG-IF2, UG-IF3, UG-IF4, UG-IF5, UG-IF6, UG-IF7, K-OP1, K-IF1, PAD 12, MM-AS1, MM-AS2, and OR-AS1. Furthermore, the re-design also avoided previously-recorded sites 36-1-0120 (H2 with PAD) and 36-1-0433 (OR-WM-ST2).

The Applicant also recognised that Aboriginal heritage values are strongly linked to the natural environment. Not only does a largely-unmodified landscape provide a setting that enhances the value of a site, but it has value in itself to Aboriginal heritage.

4.9.8.3 Minimise Impact

Noting the largest area of impact would be associated with the Liquid Residue Storage Facility (LRSF), the Applicant has, at significant cost, continued to modify the processing operations to improve water efficiency. Through this process optimisation, the water required has been reduced by approximately 20%, in turn reducing the area required for the LRSF.

When determining which of the LRSF Areas to exclude from the disturbance footprint, the occurrence of heritage sites was considered. The density of Aboriginal sites on the "Ugothery" property where LRSF – Area 7 was originally located is far higher than on those sections of the "Grandale", "Ugothery" and "Toongi Valley" properties on which LRSF – Areas 4 and 5 are located. As such, greater heritage benefit was derived from excluding LRSF – Area 7 (see **Figure 4.39**).

4.9.8.4 Mitigate / Manage Impacts

Within the context of the proposed impacts, the identified sites have been grouped as follows.

Group A: Avoidance

Impact on the 26 sites located outside the impact footprint and at no direct or indirect risk of harm would be avoided.

The locations of these sites would be clearly marked on mine plans and the areas avoided by all activities associated with the construction and operation of the mine and related infrastructure.

Group B: Avoidance with Management

Eleven sites are located adjacent to component disturbance areas and face possible indirect impacts. These specific sites (TS-ST-03 [36-1-0373], TS-IF2 [36-1-0362], TSA-OS-02 [36-1-0358], MM-AS1, MM-AS2, MM-IF1, MM-IF2, OR-AS1 with PAD, OR-ST1, ORWM-ST2 [36-1-0433] and H2 with PAD [36-1-0120]) would be managed a follows.

- DZP personnel would be alerted to their location and the location of the sites would be shown on mine plans.
- Each site would be revisited by a suitably qualified archaeologist before construction, resurveyed and temporarily fenced until earthworks in the general vicinity is complete.
- Work crews in the vicinity of any of these sites would be informed by way of an induction as to the site's location and its legislative protection under the NPW Act. All work crews would be informed that the fenced area remains a "no-go" area for the duration of the works.
- If, at the time of construction, it becomes obvious that a site in this category would be impacted by the proposed works, the site would be managed as a Group C site with specific management recommendations formulated following the site visit by a suitably qualified archaeologist.

One site (TS-GG-01) could suffer over time from modification of the drainage coming from the proposed open cut. Once the eastern half of the open cut has begun, a condition assessment schedule would be implemented to ensure that the site is not being harmed.

Group C: Sites Requiring Management

This group includes sites either partially or completely within the impact footprint where cultural material was identified but where sub-surface archaeological deposits are considered unlikely.

- Group C(i): Surface collection of artefacts

  Nine sites fall into this group: UG-AS1, GI-AS1, GI-AS2, PH-IF1, TV-AS1, TV-IF1, TS-IF-01 (36-1-0313), TS-OS-03 with PAD (36-1-0356) and TS-OS-05 with PAD (36-1-0364). Detailed recording and collection of surface artefacts would be the primary management approach for these sites.

- Group C(ii): Relocation of cultural heritage items

  Including five Aboriginal scarred trees (UG-ST1, TS-ST-04 [36-1-0365], TS-ST-05 [36-1-0366], TS-ST-06 [36-1-0367] and TS-ST-02 [36-1-0372]), the Applicant would consult with the RAPs to determine the best method to relocate these sites to a place of safekeeping.

Following discussions with the RAPs in the AFGM of 13 August 2013 (refer to Section 4.9.4.2), it has been agreed that collected surface artefacts be transferred to the custody of the RAPs via a Care Agreement which would be drafted and included in the *Aboriginal Cultural Heritage Management Plan* for the DZP. The transfer of custody of the scar-bearing portions of the scarred trees to be impacted would also be subject of a Care Agreement. This arrangement would also be formalised within the *Aboriginal Cultural Heritage Management Plan* for the DZP.

4.9.8.5 Cultural Heritage Management – General

In recognition of the fact that 38 sites are to remain undisturbed on the DZP Site and infrastructure corridors (with management in the case of 12 of these), there remains potential for sites not identified by OzArk (2013) to occur, and acknowledging the Applicant's obligations in relation to Aboriginal cultural heritage management under the NPW Act, the Applicant would abide by the following general management principles.

- Disturbance on the DZP Site, unless appropriately cleared by the RAPs, would remain within the limit of disturbance nominated in this EIS.
- Should any other objects or Aboriginal sites be identified during the course of construction, the Applicant would implement an *Unanticipated Finds Protocol*, as presented in *Appendix 5* of OzArk (2013b).
- An *Aboriginal Cultural Heritage Management Plan* (ACHMP) would be prepared, including a Statement of Commitments with respect to the management of the identified (any as yet unidentified) sites. The ACHMP would incorporate the proposed management of sites included in this EIS, measures which have been reviewed by the RAPs for the Proposal.

- The site induction process for all personnel would include Aboriginal cultural heritage as a core component. The information presented would include:
  - artefact recognition and implementation of the correct procedure if artefacts are recognised;
  - the procedure(s) that must be followed if artefacts are identified; and
  - the penalties if the procedure is not followed.

4.9.9 Assessment of Residual Impacts

4.9.9.1 Assessment of Study Area Impacts

OzArk (2013b) identifies that the Proposal would avoid impact on 38 of the 52 identified sites. Impact on the remaining 14 sites is considered unavoidable, despite the efforts of the Applicant to modify the site layout to avoid these.

OzArk (2013b) states that, taking into consideration the fact artefact salvage and/or relocation would be undertaken for the impacted sites in accordance with the management measures and operational safeguards nominated in Section 4.9.8 (to be formalised within an ACHMP prepared in consultation with the Aboriginal community), the impact of the proposed disturbance would be acceptable.

Salvaging the artefacts would effectively destroy the *in situ* sites but would ensure the safety of the artefacts which, if retained in a suitable keeping place such as a museum or Aboriginal Land Council office, would become far more accessible than they would be if not salvaged but destroyed. Following the receipt of development consent, and the approval of the ACHMP, a qualified archaeologist and Aboriginal stakeholders would revisit the 14 sites to identify on the ground all sites, recover artefacts from identified sites to be disturbed and remove any other artefacts within the footprint of disturbance.

Further site management measures may follow after the conclusion of test excavations to be completed for two sites with associated PADs. It is further noted that the residual impact on Aboriginal heritage following the adoption of the management measures and operational safeguards of Section 4.9.8 represents the minimum impact practically achievable for the Proposal.

4.9.9.2 Impact Assessment in a Regional Context

When considering whether or not to salvage certain artefacts, a further consideration is the extent to which the removal of the artefacts has a cumulative impact on the archaeological record, given that other sites in the region may have been destroyed previously.

A total of 52 sites (comprising 19 previously registered AHIMS sites and the additional 33 sites identified during the current survey) exist within the study areas. Of the sites to be impacted, only one was confirmed as having moderate scientific value (all sites were assessed as having moderate cultural value) with a further two being allocated a preliminary moderate scientific value to be reviewed following the completion of test excavations (OzArk, 2013b). With the appropriate salvaging, recording and preservation of the open scatter and isolated finds, it is anticipated that there would be minimal impact on the wider representation of historic Aboriginal habitation throughout the area.

4.9.10 Conclusion

Appropriate consultation has been, and would continue to be undertaken with the relevant stakeholders in the development of an *Aboriginal Cultural Heritage Management Plan*. That document would provide for the further collection of information in relation to the sites through the collection, salvage, recording and relocation of the identified artefacts to an appropriate keeping place determined in consultation with all stakeholders and management of sites that may be identified throughout the life of the Proposal.

As a result, the Applicant contends that the impact of the proposed activities on Aboriginal cultural heritage has, to the greatest extent practicable, been minimised.

4.10 HISTORIC HERITAGE

4.10.1 Introduction

The Director-General's Requirements (DGRs) issued by the DP&I identified "*Heritage*" including as a key assessment requirement as one of the key issues "*an **historic heritage assessment** (including archaeology)*". The DGRs also require that the historic heritage assessment "*must:*

- *include a statement of heritage impact (including significance assessment) for any State significant or locally significant historic heritage items; and,*
- *outline any proposed mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures)."*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Heritage Council which request that the EIS "*include a heritage impact assessment*" that addresses issues including:

- the identification of non-Aboriginal heritage items within the area affected by the Proposal;
- the heritage significance of the site and any impacts the development may have upon this significance; and
- consideration of the relics provisions in the *Heritage Act 1977*.

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to historic heritage and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Loss or destruction of items of heritage significance due to proposal activities (medium).

The historic heritage assessment for the Proposal was undertaken by various archaeologists of OzArk Environment and Heritage Management Pty Limited (OzArk) under the direction of Dr Jodie Benton. The resulting report is presented as Part 9 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as "OzArk (2013c)". This subsection of the EIS provides a summary of the historic heritage assessment, concentrating on those matters

raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**.

4.10.2 Assessment Methodology

The historic heritage assessment was undertaken in the following stages.

- Stage 1 – Background Research and Literature Review.

  An understanding of the archaeological context of the regional, local and DZP Site was obtained through a review of historic records of the local area, previous archaeological studies, review of archaeological databases and consultation (refer to Section 4.10.3).

- Stage 2 – Field Survey

  Eight field surveys were undertaken between May 2012 and February 2013. Section 4.10.4 presents further detail on the site inspection methodology, coverage and results.

- Stage 3 – Development of Management Strategies for the Identified Historic Heritage Sites.

  Based on the relative cultural, scientific and public significance of the identified sites, management strategies have been recommended (refer to Section 4.10.5).

- Stage 4 – Assessment of Impacts

  The significance of any sites identified or re-recorded was completed in accordance with the relevant assessment criteria and considering the adoption of the proposed management strategies, the residual impact of the Proposal on historic heritage was assessed (refer to Section 4.10.6).

4.10.3 Historic Context and Background Research

4.10.3.1 Historic Heritage Study Area

The historic heritage assessment of OzArk (2013c) considers a research study area for the Dubbo regional area to determine the historic regional and local context. The following study areas specific to each of the four main components of the Proposal were adopted by OzArk for the purposes of impact assessment**.**

- The DZP Site: comprising all areas of proposed mining, processing and associated disturbance. This study area is larger than the DZP Site reflecting the changes to the site layout that have occurred since the commencement of the historic heritage assessment.
- The Macquarie Water Pipeline: a 7.6km long and approximately 20m wide corridor for the proposed water pipeline from the Macquarie River to the DZP Site.

- The Toongi-Dubbo Rail Line: approximately 30km long and approximately 10m wide area for the proposed upgrade of the Toongi to Dubbo section of the Dubbo-Molong Rail Line.
- The Obley Road Alignment: approximately 22km long and 20m wide corridor for the proposed realignment of portions of Obley Road between the DZP Site and Dubbo.

4.10.3.2 Regional Context

European involvement in the Dubbo region has been recorded since the grant of land in the 1820s for pastoral enterprises with the first successful and permanent run occupied approximately 8km south of the current city of Dubbo. With the gold rushes of the 1850s, the area was opened up to new cattle markets with long-distance droving routes being established. Following the demise of the gold rush, the subsequent increasing labour supply saw sheep and wool production overtake the area. Dubbo prospered throughout the late nineteenth century and in particular during the 1880s following the arrival of the railway in 1881 making it a central hub for transport routes.

Five recorded items of State Heritage Significance are situated in the vicinity of the proposed rail upgrade (OzArk, 2013c), however, not within the impact footprint of the DZP Site.

- Dubbo Railway Precinct.
- Dubbo RAAF Stores Deport (used during Second World War).
- "Dundullimal" property.
- Dubbo Showground.
- "Holmes" Property.

OzArk (2013c) provides a discussion of these and other historic features of the region.

4.10.3.3 Local Context

The area to the south of Dubbo was predominantly pastoral country during the nineteenth century with "The Meadows", a pastoral property, located adjacent to the western margin of the DZP Site, being recognised as one of the earliest pastoral runs during European settlement in the region. This property was consequently subdivided with "The Springs" property being taken up in 1846 and named by Scottish immigrants Arthur Campbell Baird and his wife, Isabella. "The Springs" is of Local Historic Significance as it represents a location for early contact between Aboriginal and European people in the Dubbo region.

Additionally, another pastoral run within the locality, the Cumbooglecumbong holding / Whylandra Run. supported sheep and cattle. Slab huts on the run housed 94 people, many of whom were likely to have been convicts. The first homesteads built on the Cumbooglecumbong run are no longer extant, having been destroyed by flooding in 1867 and 1874. This holding was eventually sub-divided in approximately 1897 into a number of properties including "Cockleshell Corner", "Pacific Hill", "Glen Idol", "Karingle", "Wychitella", "Toongi Valley", "Grandale" and "Ugothery". All those properties, with the exception of "Cockleshell Corner", lie within the DZP Site.

OzArk (2013c) provides a detailed review of the historic record of the local setting, considering Toongi and surrounding properties, the rail line between Toongi and Dubbo and adjoining properties and the city of Dubbo more generally. The following provides a brief overview of the historic record / context of the village of Toongi, "Dundullimal" property and homestead, and Dundullimal Rail Bridge, being those sites most likely to be impacted by the Proposal or holding most heritage significance.

Toongi Village

The Toongi Village itself was settled relatively late in comparison to other areas in the district with a 'Settlement Lease' taken up by James Ower on 4 November 1897. The village of Toongi was notified on 6 March 1931. At that time, the village notification consisted of a recreation reserve and school site, with village lots opened up for purchase on 17 April 1931 (Hickson and Kass 2002a). The Wambangalang School, opened in 1928, continues to provide educational services (as the Wambangalang Environmental Education Centre).

A government-operated grain storage and distribution location was previously located on the Dubbo-Molong Rail Line which runs adjacent to the village. It is likely that operations on that location have involved grain bagging, storage and bulk loading on to trains. Operations ceased in 1993 following the closure of the rail line (circa 1987). Dismantling of the southern grain storage occurred between 1988 and 1995 and dismantling of the northern storage occurred between 1995 and 2000. In 2012, the site consisted of a concrete floor remnant of the northern storage and an asphalt floor remnant of the southern storage.

As part of the Dubbo City Rural Areas Community based Heritage Review completed for the State Heritage Inventory (Hickson and Kass, 2002b) it is noted that Toongi holds nil heritage significance (OzArk, 2013c)[2].

Dundullimal (Property and Homestead)

"Dundullimal" is a pastoral property located on Obley Road on the southern bank of the Macquarie River, _2.3km south of the Obley Road intersection with the Newell Highway. The homestead (see **Figure 4.42**) is regarded as holding national and state heritage significance. It is one of few surviving early pastoral homesteads and is the oldest building in Dubbo (c. 1842) and may be the oldest existing house outside Governor Darling's original Nineteen Counties.

The homestead portion of "Dundullimal" was granted to the National Trust of Australia (NSW) in 1985 (OzArk, 2013c).

Dundullimal Rail Bridge

The Dundullimal Rail Bridge traverses the Macquarie River and is one of two J.W. Roberts standard design steel Pratt truss railway bridges built during 1925 on the now-disused Dubbo-Molong Rail Line. The bridge is approximately 300m in total length and approximately 5m in maximum width. The heritage significance of the bridge was previously assessed by OzArk (2010) and afforded local heritage significance.

[2] The 'Assessed Significance' field of the SHI inventory sheet is blank.

4.10.3.4 Background Research

OzArk (2013c) reviews the following primary resources to identify the relevant historic heritage significance within the study areas.

- Archived historical newspapers located at the National Library of Australia's (NLA) Trove.
- Archived historical parish maps located at the NSW Land and Property Information's (LPI) Parish Maps Preservation Project and Pixel websites.
- The National Archives of Australia's (NAA) 'Your story, our history' collection of defence service records.

Secondary resources used to identify the relevant historic heritage significance within the study areas include the following.

- Dormer's two-volume history of the Dubbo region (Dormer 1987, Dormer, 1988).
- Community heritage studies commissioned by the Dubbo City Council (Hickson and Kass, 2002a, 2002b, 2002c, 2002d; Christo Aitken & Associates, 2007).

OzArk (2013c) reviewed the following heritage registers and databases on the 15 October 2012 to identify sites of historic heritage significance within the Dubbo LGA.

- Australian Heritage Database: 24 places were identified within the Dubbo LGA.
- NSW Heritage Office State Heritage Register: five items within the vicinity of the proposed upgrades to the crossings of the Toongi-Dubbo Rail Line were identified.
- State Heritage Inventory: eight places were identified at Toongi, however none within the DZP Site.
- Department of Sustainability, Environment, Water, Population and Communities Protected Matters Database: no places of historic heritage were identified.
- *Dubbo Local Environmental Plan 2011*: 260 places were identified within the Dubbo Local Government Area (LGA).

Consultation was also undertaken with current landowners of Toongi area, including Megan Brennan, Kevin Hyland, John Hyland, Gwen Harper, John Tucker, the Rotherys of "Toongi Valley" and the Greys of "Grandale", regarding property histories and other information that would assist with the surveys.

4.10.4 Field Survey Methodology and Results

4.10.4.1 Survey Methodology

A survey for historic heritage sites was undertaken concurrently with the survey for Aboriginal heritage involving a combination of pedestrian and vehicle transects (see Section 4.9.7). All structures within the DZP Site, Macquarie River Water Pipeline Corridor, Obley Road Realignment and the proposed upgrade of crossings for the Toongi-Dubbo Rail Line were recorded together with observations of the overall historical significance of the wider agricultural landscape where relevant.

4.10.4.2 Survey Results and Significance Assessment

In total, six new historical heritage items in addition to the Dundullimal Rail Bridge, were identified during the surveys. Of these, four were described as historical sites (HS) and two were described as historical isolated finds (HIF) as follows (**Figure 4.42**).

- DZP-HS1 Brick and concrete footings. This site consists of frogged bricks and stamped bricks with 'IFB' or 'CRITIX' and concrete footings approximately 10m from the existing rail line.
- DZP-HS2 Cumboogle Rail Bridge. This rail bridge consists of metal and concrete supports with wooden railroad tiles embossed with '1970'.
- DZP-HS3 Hyandra Rail Bridge. This railway bridge is constructed entirely of timber with metal fasteners and rails which obstructs fallen timber within the watercourse.
- DZP-HS4 Dundullimal / Miriam Timber Rail Bridge. This rail bridge is constructed entirely of timber with metal fasteners and rails and has been assessed as in fair condition as a result of fire and neglect.
- DZP-HIF1 Brown glass bottle. This bottle is embossed with '1926' and 'The Bottle Company'.
- DZP-HIF2 Rail piece with two holes.

4.10.5 Management and Mitigation Measures

The following management and mitigation measures would be implemented to minimise the potential for adverse Proposal-related impacts on historic heritage sites within and surrounding the DZP Site.

- Identify on relevant plans all identified sites and ensure that activities in the vicinity of those sites are appropriately managed.
- Avoid impacts on sites DZP-HIF1 and DZP-HIF2 by establishing a fence and buffer zone around the sites.
- Unless unavoidable due to rail line upgrade, avoid DZP HS1.
- Document and record sites DZP-HS2, DZP-HS3 and DZP-HS4, prior to dismantling, and provide this record to Dubbo City Council and the NSW State Archives. Site DZP-HS2 is not recorded as having significance, however, would be documented together with the timber railway crossings to be dismantled and replaced.

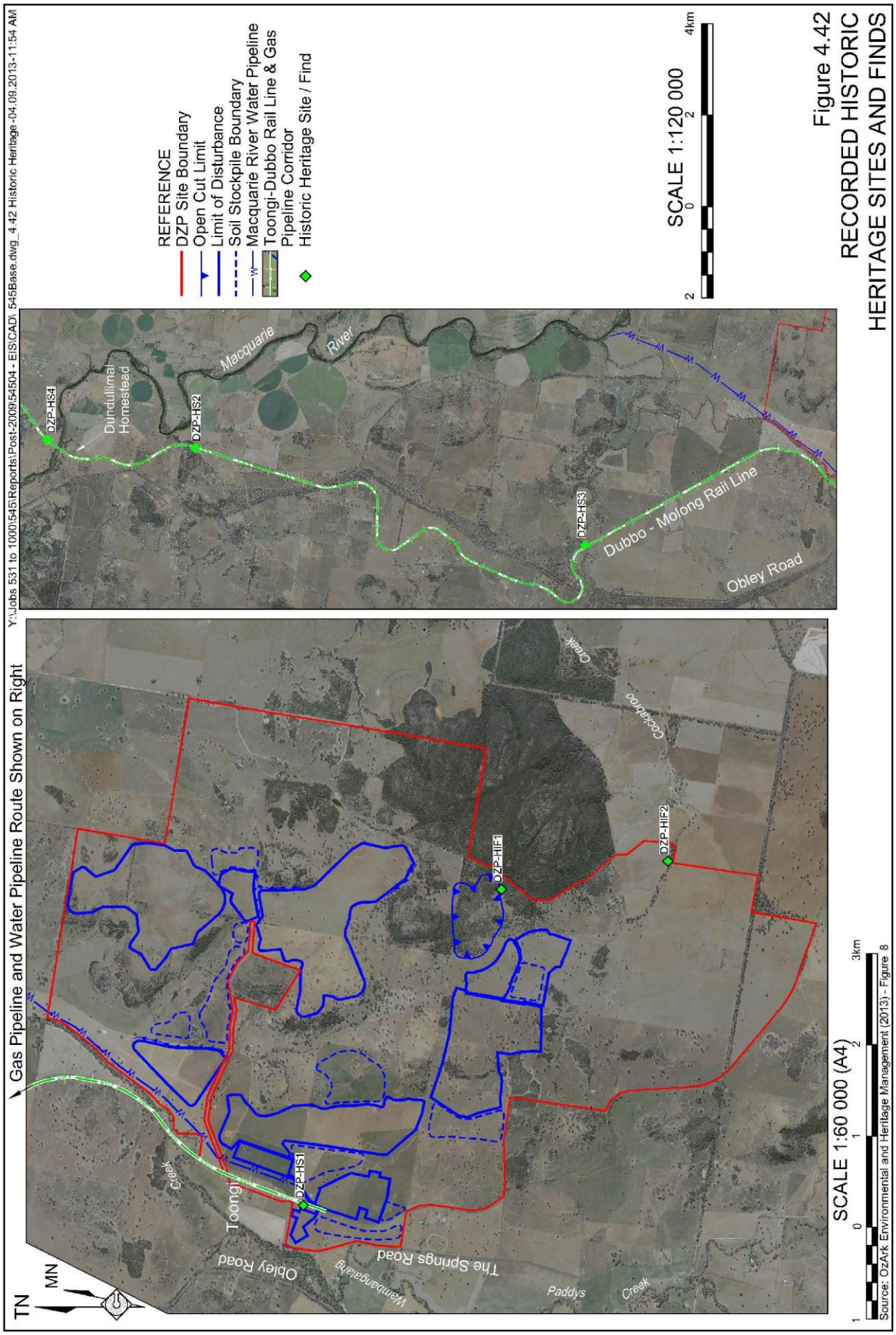
Figure 4.42
RECORDED HISTORIC HERITAGE SITES AND FINDS
REFERENCE
DZP Site Boundary
Open Cut Limit
Limit of Disturbance
Soil Stockpile Boundary
Macquarie River Water Pipeline
Toongi-Dubbo Rail Line & Gas Pipeline Corridor
Historic Heritage Site / Find
SCALE 1:120 000
SCALE 1:60 000 (A4)
Gas Pipeline and Water Pipeline Route Shown on Right
DZP-HS1
DZP-HS2
DZP-HS3
DZP-HS4
DZP-HIF1
DZP-HIF2
Dundullimal Homestead
Macquarie River
Dubbo - Molong Rail Line
Obley Road
Toongi
Obley Road
The Springs Road
Wambangalang
Paddys Creek
Cookeboo Creek
TN
MN
Source: OzArk Environmental and Heritage Management (2013) - Figure 8

- If items of suspected historic heritage significance are identified throughout the life of the Proposal, the following procedures would be implemented.
    1. Step 1 – No further earth disturbing works would be undertaken in the vicinity of the suspected item of historic heritage significance.
    2. Step 2 – A buffer of 20m x 20m would be established around the suspected artefact. No unauthorised entry or earth disturbance would be allowed within this buffer zone until the area has been assessed.
    3. Step 3 – A qualified archaeologist would be contacted to make an assessment of the discovery. Mitigation procedures would then be developed and implemented based on the assessment.

4.10.6 Assessment of Residual Impacts

4.10.6.1 Residual Impacts

Based on the proposed layout of the DZP Site and upgrade of the Toongi-Dubbo Rail Line, disturbance to four recorded sites (DZP-HS2, DZP-HS3, DZP-HS4, and the Dundullimal Rail Bridge) would be unavoidable. Impact to Site DZP-HS1 would be avoided subject to rail upgrade requirements.

4.10.6.2 Significance of Identified Historic Sites and Items

OzArk (2013) undertook an assessment of the significance of the identified sites based on the principles identified in the Heritage Council of NSW significance criteria. **Table 4.66** summarises the overall heritage significance of the identified historic sites and items.

Table 4.66
Heritage Significance of Historic Sites and Items

Site	Heritage significance	Comments
DZP-HS1	Nil	Does not yield new information relating to railways or settlement within the region within the region.
DZP-HS2	Nil	Common and well understood bridge building techniques. Does not yield new information relating to railways within the region.
DZP-HS3	Local	Does not yield new information relating to railways within the region.
DZP-HS4	Local	Associated with the previously assessed Dundullimal Rail Bridge and therefore the Dubbo-Molong Rail Line. Derives significance from this association.
DZP-HIF1	Nil	Ordinary item unable to yield new information about settlement within the region.
DZP-HIF2	Nil	Ordinary item unable to yield new information about railways within the region.
Dundullimal Rail Bridge	Local	Significance assessed by OzArk (2010).
Source: Modified after OzArk (2013c) – Table 10		

Tables 11 to *14* of OzArk (2013c) provide more detailed assessment of each of these sites against the seven criteria of the Heritage Council of NSW's manual *Assessing Heritage Significance* (Heritage Council of NSW, 2001).

4.10.6.3 Assessment of Regional Historical Context

As recognised on the Dubbo LEP 2011, the Dubbo Railway Precinct is listed as having State historical significance. While the Toongi-Dubbo Rail Line upgrade in the Study Area has not been listed, the Applicant has demonstrated the appropriate mitigation measures to ensure the integrity of the line is maintained, and as required, the documented archival of the relevant bridges prior to any works being undertaken. There would be negligible residual impact on the regional historical context by the Proposal.

4.10.6.4 Assessment of Local Historical Context

As discussed in Section 4.10.6.1, four recorded historical heritage sites (DZP-HS2, DZP-HS3, DZP-HS4 and the Dundullimal Rail Bridge) would be impacted by the Proposal. As a result of the proposed mitigation measures to upgrade the Dundullimal Rail Bridge keeping the historical integrity of the structure, and the documented archival recording prior to the other crossings being dismantled, there would be negligible residual impact on the local historic context by the Proposal.

4.10.7 Conclusion

The Applicant has taken all historic heritage sites into consideration for the planning of the Proposal. The required upgrades to the Toongi-Dubbo Rail Line to transport materials from the DZP Site would result in the improvement of the line, which has not been used since 1984. The rail crossings, to be dismantled and replaced as part of the line upgrade, are currently not listed on any Commonwealth, State or Local registers as having any historical significance. Despite this, the Applicant would provide a documented record of the structures prior to dismantlement to be appropriately archived for future historical research. As a result, OzArk (2013c) conclude that there would be negligible impacts on historic heritage.

4.11 SOILS AND LAND CAPABILITY

4.11.1 Introduction

The Director-General's Requirements (DGRs) issued by DP&I identified "*Land Resources*" as a key assessment requirement including "a *detailed assessment of the potential impacts on* ***soils and land capability*** *(including salinisation and contamination)*".

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Environment Protection Authority (EPA) which requested that the EIS provide "*an assessment of potential impacts on soil and land resources*"; the Central West Catchment Management Authority which requested that the EIS "*outline the soil types covered in the proposed site and outline how the operation will mitigate risks in regard to the removal of the topsoil, storage of the overburden, replacement of the waste material and rehabilitation of the area upon completion of operation*"; and the Division of Resources & Energy (DRE) of DTIRIS which requested that the EIS "*outline and map soil characteristics across all proposed areas of surface disturbance and assesses their value and limitations for rehabilitation"*. DRE also requested that:

- *significant limitations need to be addressed in terms of their impact on rehabilitation; and*
- *land capability and agricultural suitability mapping also needs to be undertaken and presented.*

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to soils and land capability and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Rehabilitation outcomes not meeting objectives (high).
- Reduced productivity on final landform (high).
- Increased erosion on the final landform (high).

The soils and land capability assessment for the Proposal was undertaken by Messrs Pat Hulme and David Duncan of Sustainable Soils Management Pty Ltd (SSM). The resulting report is presented as Part 10 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as "SSM (2013)". This subsection of the EIS provides a summary of the soils and land capability assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**.

4.11.2 Existing Environment

4.11.2.1 Regional Soil Environment

4.11.2.1.1 Soil Landscapes and Soil Types

The former Department of Land and Water Conservation prepared the Soil Landscapes of the Dubbo 1:250 000 Sheet (Murphy and Lawrie, 1998) which records nine soil landscapes as occurring within the DZP Site. SSM (2013) has divided these into the five classes as presented in **Table 4.67**.

Table 4.67
Summary of Soil Landscapes in the Soil Survey Area

Soil Class	Landscape	Landscape Summary
Alluvium	Mitchell Creek (Mi)	Recent alluvial deposits with highly variable soils including sandy Stratic Rudosols and loamy alluvial soils (Brown Dermosols) along Wambangalang Creek. Land Class 2 (6 in drainage lines.
Chromosols (Duplex, but not acidic)	Arthurville (Ar)	Gently undulating rises and undulating low hills with mixed sedimentary and volcanics in Cowra Trough. Red Chromosols with Yellow Sodosols along drainage lines. Land Class 3 to 5.
	Ballimore (Bm)	Undulating low hills on flat lying Napperby formation of sandstone, conglomerates ferruginous material and siltstone. Red Chromosols with Siliceous Sands on steeper scarps and Yellow Sodosols on lower slopes and depressions. Land Class 3 to 5.
Red Podzolics (Duplex and Acidic)	Belowrie (Bi)	Rises and low hills Jurassic trachyte. Red Chromosols Land Class 4 with Red Kandosols and Brown Chromosols on more stable lower slopes Class 3 and Yellow Sodosols on flatter lower areas. Shallow Rudosols and Tenosols on rocky crests. Hard setting and acidic surfaces.
	Splitters Hill (Sh)	Undulating and rolling hills on Silurian vertically bedded shale and sandstone. Mainly Red Chromosols but a variety of others depending on parent material. If sandstones are present the soils can be very acidic and have aluminium toxicity. Land Classes range from 3 to 6 depending on geology.
Euchrozems (Clayey soil with little shrink/swell capacity)	Bald Hill (Bh)	Low hillocks with moderately steep slopes. Basalt rock outcrop and shallow Red Ferrosols Land Class 6 and Brown Ferrosols Class 4 & 5 on lower slopes.
	Wongarbon (Wg)	Gently undulating and low hills with minor basaltic hillocks. Red Ferrosols and Red & Brown Vertosols with linear gilgais. Fertile soils.
	Nubingerie (Nb)	Undulating low hills mainly andesites from Cowra trough. Red Ferrosols Land Class 3 and Red & Brown Vertosols Class 2.
Shallow Soils	Dowd (Dw)	Hills of rock pavements and scarps. Trachyte volcanic plugs may be sodic. Shallow soils Leptic Rudosols low fertility not suitable for stripping. Land Classes 7 & some shallow Red Chromosols Class 6.
Source: Modified after SSM (2013) – Table 1		

Three of these five classes, Chromosols, Red Podzolics and Shallow Soils form a continuum from deeper soil in the footslopes and depositional parts of the landscape through strongly leached soil (Red Podzolics) in mid and upper slopes to the shallow soil on the crests of hills. The more clayey Euchrozems appear to be associated with the Jurassic basalts in the northern part of the soil survey area, and older volcanic rocks near the southeastern corner of the soil survey area. The alluvial Mitchell Creek landscape was mapped only along the Wambangalang Creek floodplain.

4.11.2.1.2 Land and Soil Capability

Land and soil capability assessment is based on the slope, wind hazard, soil pH, surface structural stability, salinity, rocky outcrop, waterlogging potential and existing erosion of a landform. SSM (2013) based its determination of land capability on the NSW Office of Environment and Heritage Land and Soil Capability Assessment Scheme (OEH, 2012). **Table 4.68** summarises the appropriate land use for each capability class.

Table 4.68
Land and Soil Capability Classes

Land Capability Class	Most Intensive Use	Land Definition
Class 1	Regular Cultivation including intensive crops	Prime agricultural land and the best cropping country in the catchment
Class 2	Regular Cultivation	Very good cropping land with fertile soils and short, gradual slopes
Class 3	Regular cultivation, but must be consciously managed to prevent degradation	Moderate limitations that can be managed by more intensive management practices
Class 4	Grazing, intermittent cultivation with specialised practices	Moderate to severe limitations for more intensive use (e.g. cropping). Limitations more easily managed for grazing
Class 5	Grazing, very occasional cultivation for pasture establishment	Severe limitations for cropping and other high impact land management. Moderate limitations for grazing
Class 6	Grazing only	Severe limitations for wide range of land uses
Class 7	Unsuitable for rural production	Includes steep (slope 33% to 50%) or extremely erodible, or saline or shallow
Class 8	Unusable for any agricultural purpose	Extremely severe limitation, includes precipitous slopes (>50%), areas with large proportion of rock outcrop and frequently inundated
Source: OEH (2012), (Central West CMA, 2008)		

Considering the soil landscape units mapped over the DZP Site, the majority of the soil survey area was described as having moderate (Class 3) to severe (Class 5) limitations for agriculture according to the Central West CMA (2008) system (SSM, 2013). The land most suitable for agriculture is contained within the landscapes of the Alluvium and Euchrozems soil classes.

4.11.2.1.3 Dryland Salinity Considerations

Dryland salinity is the build up of salts in the soil surface in non-irrigated areas and is usually the result of three broad processes, namely, groundwater recharge, groundwater movement and groundwater discharge. Effectively, dryland salinity occurs as a result of saturation and drying cycles within the soil or at surface resultant from rising and falling of brackish or saline groundwater. The accumulated salts that remain following evaporation or evapotranspiration increase the salinity of the soil.

A regional scale groundwater and dryland salinity investigation carried out in 2001 by the then NSW Department of Land and Water Conservation (DLWC) identified the Toongi Catchment as prone to significant salinity (Smithson, 2001). The occurrence of dryland salinity in the Toongi Catchment typically occurs in the upper and mid-slopes and along drainage lines. Potential groundwater discharge and saline sites within and surrounding the DZP Site have been identified as surface drainage lines, break of slope and on the valley floors or alluvial flats (Smithson, 2001). Areas at greatest risk of dryland salinity are those where the groundwater table is within 5m of the natural ground surface.

Known areas of dryland salinity have been mapped for the Toongi Catchment, which includes the DZP Site, and based on *Figure 6* in Smithson (2001) there are no recorded saline sites within the DZP Site. *Figure 13* in Smithson (2001) indicates that less than 5% of the DZP Site is expected to have water-tables within 5m of the natural ground surface, situated within the alluvium of Paddys, Wambangalang and possibly Cockabroo Creeks. This is supported by the assessment of groundwater conditions prepared by EES (2013) (see Section 4.6.5.5) which also identifies local discharge points ('springs') on several drainage lines of the DZP Site where the groundwater incises surface topography when the groundwater table is elevated.

Noting the dryland salinity potential of parts of the DZP Site, SSM (2013) uses the Hydrogeological-Landscape framework (HGL)[3] to assess salinity hazard of the local setting. SSM (2013) map seven hydrogeological landscape units (HGLU)[4] over the DZP Site and immediate surrounds (refer to *Figure 6b* of SSM, 2013). SSM (2013) considers the greatest salinity hazard is associated with the Napperby Formation (HGL 37) which occupies the majority of the DZP Site (excluding the elevated hill tops and ridges over Jurassic volcanic geology and some areas of the lower alluvial flats). Consistent with the discussion of dryland salinity above, SSM (2013) notes that the most likely landscape position for salinity to develop is near the break of slope between the steep midslope of hillsides and the flatter foot-slopes.

Section 2 of SSM (2013) provides additional information in relation to the regional soil setting and geological and hydrogeological features.

4.11.2.2 Assessment Methodology

Figure 4.43 illustrates the study area of the SSM (2013) assessment of soils ("soil survey area") which incorporates the DZP Site, as well as the land surrounding the DZP Site that would be acquired by the Applicant on approval of the Proposal (see also **Figure 1.2**).

Initially, SSM (2013) undertook a preliminary soils assessment using two slightly different electromagnetic geophysical surveys, namely an EM31 survey and EM38 survey. These survey techniques use magnetic fields to induce electrical currents in the soil materials which in turn induce a secondary magnetic field which is detected by an instrument at the surface. The strength of the induced electrical current, and therefore the secondary magnetic field, would vary depending on the nature of the soil material in the vicinity of the transmitter. As a result, variation in the detected secondary magnetic field would reflect variation in the physical properties of the underlying soil material. The EM38 survey method detects variation in soil materials to a depth of approximately 1.5m, while the EM31 survey method detects variation in soil materials to a depth of approximately 6m.

Using the results of the preliminary EM survey, 24 soil test pits were excavated to a maximum depth of approximately 3m to expose the soil profile. These test pits were supplemented by a further 29 core samples to depths of 1.5m (or refusal) (see **Figure 4.43**) and five documented soil observations. Selected soil properties in each pit were described and field measurements taken. Further laboratory soil chemical analysis of selected profiles was then undertaken.

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[3] The Hydrogeological-Landscape framework builds on the groundwater flow system framework (Coram, 1998; Walker et al, 2003) that was developed to assist in the management of groundwater salinity.

[4] Hydrogeological-Landscape Units integrate information on lithology, bedrock structure, regolith (including soils), landforms, climate (including rainfall, seasonality, and evaporation) and vegetation. These components all influence the recharge, transmission, storage and discharge characteristics of a particular hydrological system.

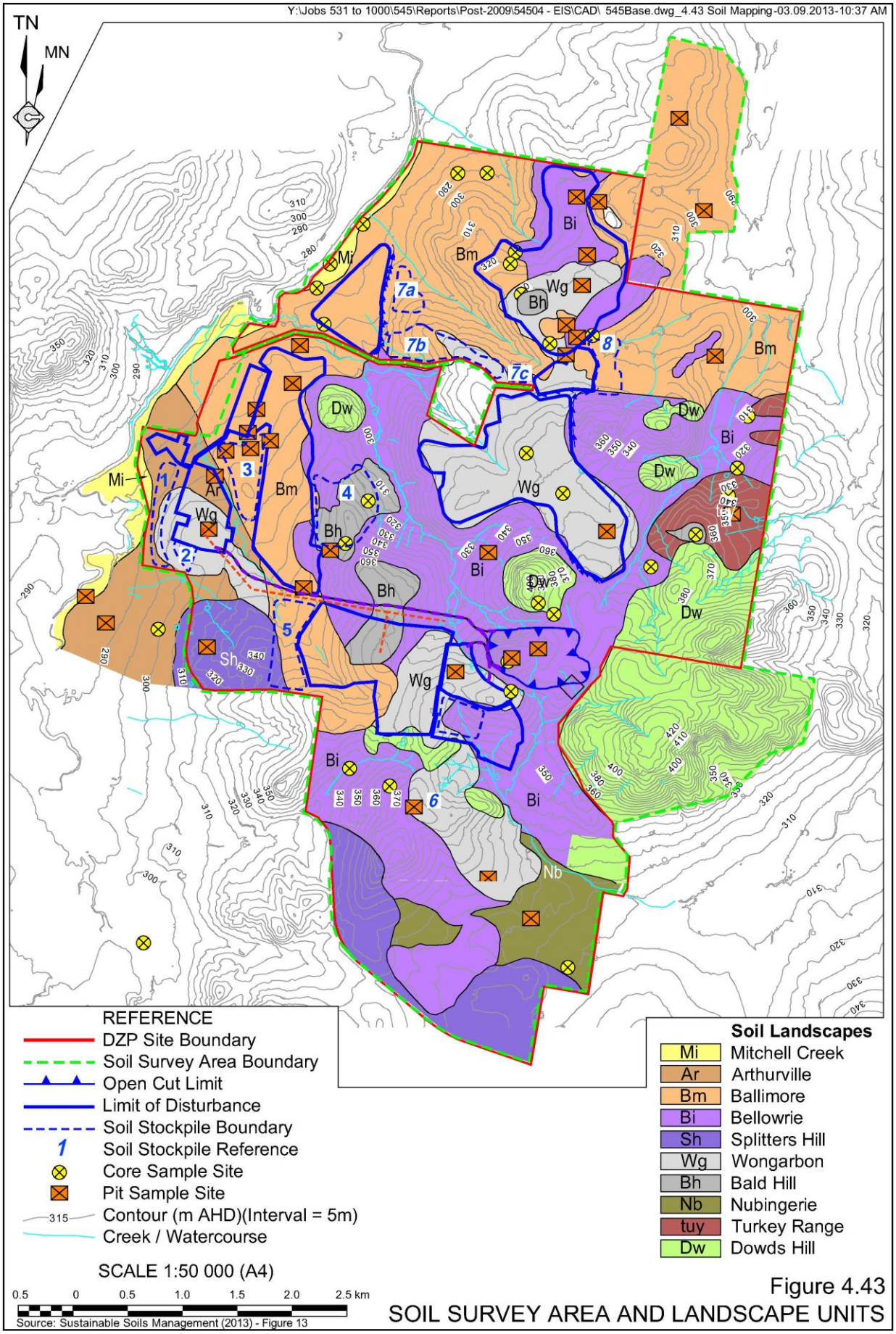

Figure 4.43
SOIL SURVEY AREA AND LANDSCAPE UNITS

This information was reviewed in conjunction with nine soil profile descriptions and lithological logs from 23 piezometers recorded during previous investigations in 2002, regional soil setting detail and aerial imagery to define the soil units and accurately define the soil landscape boundaries. Specific emphasis was placed on assessing the geotechnical properties of the different soil landscape units and suitability for the construction of the LRSF.

Detailed descriptions of the assessment methodology are presented in Section 3 of SSM (2013).

4.11.2.3 Survey Area Soils

Based on the results of the survey, the soil landscape boundaries identified in the 1:250 000 regional mapping have been adjusted by SSM (2013) and ten soil landscapes identified within the Soil Study Area (see **Figure 4.43**). The soil landscapes were generally correlated with the underlying geology. A summary of the properties of the identified soil landscape units is provided as follows.

Belowrie (Bi) Soil Landscape

The Belowrie Soil Landscape covers an area of 960ha (28%) of the soil survey area and comprises undulating, occasionally rolling, rises and hills on weathered Jurassic trachyte. The crests are dominated by shallow, rocky Rudosols, with shallow to moderately deep Red Chromosols on gentle midslope positions and shallow to deep Red and Yellow Sodosols on footslopes and along drainage lines.

Soil testing indicated that the soils have a relatively low to moderate capacity to store nutrients, neutral topsoil with moderate organic carbon content, low nutrient levels, low salinity in surface layers and moderate salinity in the subsoil. The soil was moderately to strongly dispersive throughout the profile and the calculated soil erodibility factor is between 0.036 (moderate) to 0.046 (high).

Areas of this soil landscape at the northern end of the DZP Site present flatter landforms and deeper soils and are considered suitable for the construction of the LRSF.

Ballimore (Bm) Soil Landscape

The Ballimore Soil Landscape covers an area of 940ha (27%) of the soil survey area and comprises footslopes and some undulating low hills located on the Triassic Napperby Formation, principally sandstone, conglomerates, ferruginous material and siltstone. The Ballimore Soil Landscape is dominated by deep Red Chromosols with possible localised very deep Yellow Sodosols on lower slopes and depressions.

Soil testing indicated that the soils have a relatively small capacity to store nutrients, moderately acid topsoil and neutral subsoil with moderate organic content in the surface 10cm, low nutrient levels and low salinity. The surface layers were moderately dispersive with deeper layers only slightly stable. The calculated soil erodibility factor for two test pits was 0.041 (high) and for a third 0.026 (moderate).

The combination of relatively coarse particle size, low shrinkage, and low dispersion indicate that the material sampled in the Ballimore Landscape is likely to be suitable for use in the construction of embankments.

Wongarbon (Wg) Soil Landscape

The Wongarbon Soil Landscape covers an area of 450ha (13%) of the soil survey area and comprises gently undulating low hills with minor basaltic hillocks, often with linear gilgai. The Wongarbon Soil Landscape contains moderately deep Red Ferrosols and deep Red and Brown Vertosols with occasional very deep Vertic Red Dermosols (possible Ferrosols) where soil is deep but drainage is impeded below the soil.

Soil testing indicated that the soils have a moderate capacity to store nutrients, neutral topsoil with moderate organic carbon content, moderate nutrient levels and low salinity (but measurable in some subsoil samples). Minimal dispersion tendency and calculated soil erodibility factor between 0.013 and 0.020 (low).

Presenting a plastic clay layer, these soils from this landscape unit are considered suitable for the construction of the LRSF (subject to additional and engineering specific testing). The shrinking and swelling nature of the soil indicate that care should be taken to thoroughly compact material used in embankments to avoid degradation of embankments by tunnelling.

Dowd (Dw) Soil Landscape

The Dowd Soil Landscape covers an area of 445ha (13%) of the soil survey area and comprises hills of rock pavements and scarps on weathered Jurassic trachyte volcanic plugs. The soils are very shallow Leptic Rudosols, with pockets of shallow Red Kandosol.

Field tests indicate the soils are non dispersive and would likely be suitable for stripping. Due to the shallow nature of the soils and minimal area of proposed disturbance within this landscape chemical properties were not assessed.

This soil landscape presents a thin soil layer and is located on landforms unsuitable for construction of the LRSF.

Splitters Hill (Sh) Soil Landscape

The Splitters Hill Soil Landscape covers an area of 193ha (6%) of the soil survey area and comprises undulating and rolling hills located on Silurian vertically bedded shale and sandstone. The Splitters Hill Soil Landscape contains mainly Red Chromosols although a variety soils occur depending on parent material.

Soil testing indicated that the soils have a relatively small capacity to store nutrients, moderately acidic topsoil with moderate organic carbon content, low nutrient levels and low salinity. The soil was moderately dispersive and has a calculated soil erodibility factor of 0.031 (moderate).

The soil profile of this soil landscape unit is considered too shallow to be suitable for the construction of salt crystallisation cells as part of the LRSF.

Arthurville (Ar) Soil Landscape

The Arthurville Soil Landscape covers an area of 168ha (5%) of the soil survey area and comprises gently undulating rises and undulating low hills. The Arthurville Soil Landscape is located on Silurian sedimentary and volcanic units, and contains very deep Red Chromosols with Yellow and Brown Sodosols along drainage lines.

Soil testing indicated that the soils have a relatively small capacity to store nutrients, moderately acidic topsoil with moderate organic carbon content, moderate nutrient levels and low salinity. The surface layers were moderately dispersive with soil deeper than 30cm strongly dispersive. The calculated soil erodibility factor is 0.026 (moderate).

Presenting a deep clay layer below silty sand, the soils from this soil landscape unit are considered suitable for the construction of the LRSF (subject to additional and engineering specific testing).

Nubingerie (Nb) Soil Landscape

The Nubingerie Soil Landscape covers an area of 101ha (3%) of the soil survey area and comprises undulating low hills located on Silurian andesites and metasediments. The Nubingerie Soil Landscape is dominated by moderately deep to very deep Red and Yellow Chromosols but also contains Red and Brown Vertosols.

Soil testing indicated that the soils have a relatively small capacity to store nutrients, moderately acidic topsoil with moderate organic carbon content, adequate phosphorous but other nutrients at low levels and low salinity. The calculated soil erodibility factor is 0.021 (moderate). The relatively low K value indicates the soil is relatively stable.

Presenting a moderate clay layer below sandy soil and over weathered andesite, the soils from this soil landscape unit are considered suitable for the construction of the LRSF (subject to avoiding the drainage lines which dissect the landform on which this soil occurs).

Bald Hill (Bh) Soil Landscape

The Bald Hill Soil Landscape covers an area of 84ha (2%) of the soil survey area, comprises low hillocks with moderately steep slopes on basalt rock outcrop and is dominated by shallow to moderately deep Red Ferrosols.

Soil testing indicated that the soils have a moderate capacity to store nutrients, moderately acidic topsoil with moderate organic carbon content, adequate phosphorous but other nutrients at low levels and low salinity. The surface layers were moderately dispersive, while the subsoil layers were more stable. The calculated soil erodibility factor is 0.019 (low).

The moderately high shrink and swell capacity of the material, along with the undulating nature of the landform on which it occurs, are such that it is not considered suitable for the construction of the LRSF.

Mitchell Creek (Mi) Soil Landscape

The Mitchell Creek Soil Landscape covers an area of 72ha (2%) of the soil survey area and comprises Quaternary alluvial deposits on floodplains along Wambangalang Creek. The Mitchell Creek Soil Landscape has highly variable soils including sandy Stratic Rudosols and very deep Brown Dermosols.

Soil testing indicated that the soils have a relatively small capacity to store nutrients, moderately acidic topsoil with moderate organic carbon content, adequate phosphorous but other nutrients at low levels and low salinity. The surface layers were moderately dispersive with soil deeper than 30cm strongly dispersive. The calculated soil erodibility factor is 0.031 (moderate).

This soil landscape is located too close to Wambangalang Creek to be considered as a course of materials for the construction of the LRSF.

Turkey Range (Tr) Soil Landscape

The Turkey Range Soil Landscape covers an area of 68ha (2%) of the soil survey area and comprises undulating to rolling low hills and hills on Jurassic Purlewaugh Formation sandstones, shales, lutite and mudstones with broad crests and gently sloping upper footslopes. The Turkey Range Soil Landscape is dominated by shallow to moderately deep Brown Kurosols and Yellow Sodosols.

Soil testing indicated that the soils have a relatively small capacity to store nutrients, moderately acidic topsoil with moderate organic carbon content, low nutrient levels and low salinity. All layers were moderately dispersive and the calculated soil erodibility factor is 0.032 (moderate).

The soils of this soil landscape are fragile and not considered suitable for the construction of the LRSF.

4.11.2.4 Soil Stripping Suitability

The stripping suitability of each soil landscape unit varies based on depth of soil and specific physical or chemical properties. **Table 4.69** presents the stripping suitability of each soil landscape unit as recommended by SSM (2013).

Table 4.69
Soil Stripping Suitability

Soil Landscape Unit	Maximum Stripping Depth (cm)		Comments
	Topsoil	Subsoil	
Belowrie	15	50	Generally no restrictions for stripping (to depths nominated), however, soil may be variable and each locations should be assessed prior to stripping.
Ballimore	25	75	Careful handling of topsoil required to avoid compaction. Mottling of subsoil observed and stripping would not be undertaken once mottled soils observed.
Wongarbon	25	75	Clayey soil is less susceptible to structural degradation if it is worked when it is moderately dry.
Dowd	10	10	Shallow soil profile.
Splitters Hill	10	40	Shallow soil profile.
Arthurville	30	70	Generally no restrictions for stripping (to depths nominated).
Nubingerie	10	35	Mottling of subsoil observed and stripping would not be undertaken once mottled soils observed.
Bald Hill	15	75	Shallow soil profile, however, generally no restrictions for stripping (to depths nominated).
Mitchell Creek	25	75	Mottled subsoil may be present and stripping would not be undertaken once observed.
Turkey Range	-	-	Fragile soil
Source: Modified after SSM (2013) – Section 4.2.2			

4.11.2.5 Land and Soil Capability

SSM (2013) allocated each soil landscape unit discussed in Section 4.11.2.3 a range of land and soil capability classes and then identified a dominant class (see **Figure 4.44**). The dominant land and soil capability classes are 3 (grazing and regular cultivation) and 4 (grazing and sufficient cultivation to establish improved pasture), which together account for 83% of the soil survey area. However, it is noted that, due to the broad scale of the assessment, patches of lower capability land (higher land and soil capability class number) would occur within the classified areas.

Observations by SSM (2013) during the assessment indicated that most of the land that is classified as Class 2, 3 and 4 has been cultivated at some time. Cultivation has been most frequent in the better parts of the Class 3 land, and principally in the Ballimore, Wongarbon and Nubingerie Soil Landscapes. Cultivation has been less frequent in the steeper and more rocky parts of these landscapes.

Table 4.70 provides the land and soil capability of those areas of the DZP Site to be disturbed. Approximately 75% of this land is Class 3 with the remainder Class 4 or Class 7. Notably, of the 613.1ha of higher Class 3 land to be disturbed, the majority (503ha) would be subject to disturbance where a return to this land and soil capability is considered possible. The remaining 110.1ha (18%) would be subject to disturbance where the landform would be so altered as to make a return to this class unlikely, e.g. WRE, SRSF and Salt Encapsulation Cells. There would be greater disruption to the Class 4 land with approximately 45% being subject to the major disturbance of the open cut, WRE, SRSF and Salt Encapsulation Cells.

Table 4.70
Land Capability of the DZP Site to be Disturbed

Infrastructure Type	3	4	7	Total
Open Cut	0.0	40.3	0.0	40.3
Waste Rock Emplacement	18.8	1.6	0.0	20.4
Solid Residue Storage Facility	85.5	16.2	1.1	102.8
Liquid Residue Storage Facility	381.0	44.4	0.0	425.4
Salt Encapsulation Cells	5.8	28.7	0.1	34.6
Haul Road	2.9	4.4	0.0	7.3
ROM Pad	4.2	0.0	0.0	4.2
Processing Plant	26.5	16.8	0.0	43.3
Soil Stockpiles	88.4	41.0	0.0	129.4
Total	**613.1**	**193.4**	**1.2**	**807.7**
Source: Modified after SSM (2013) – Table 28				

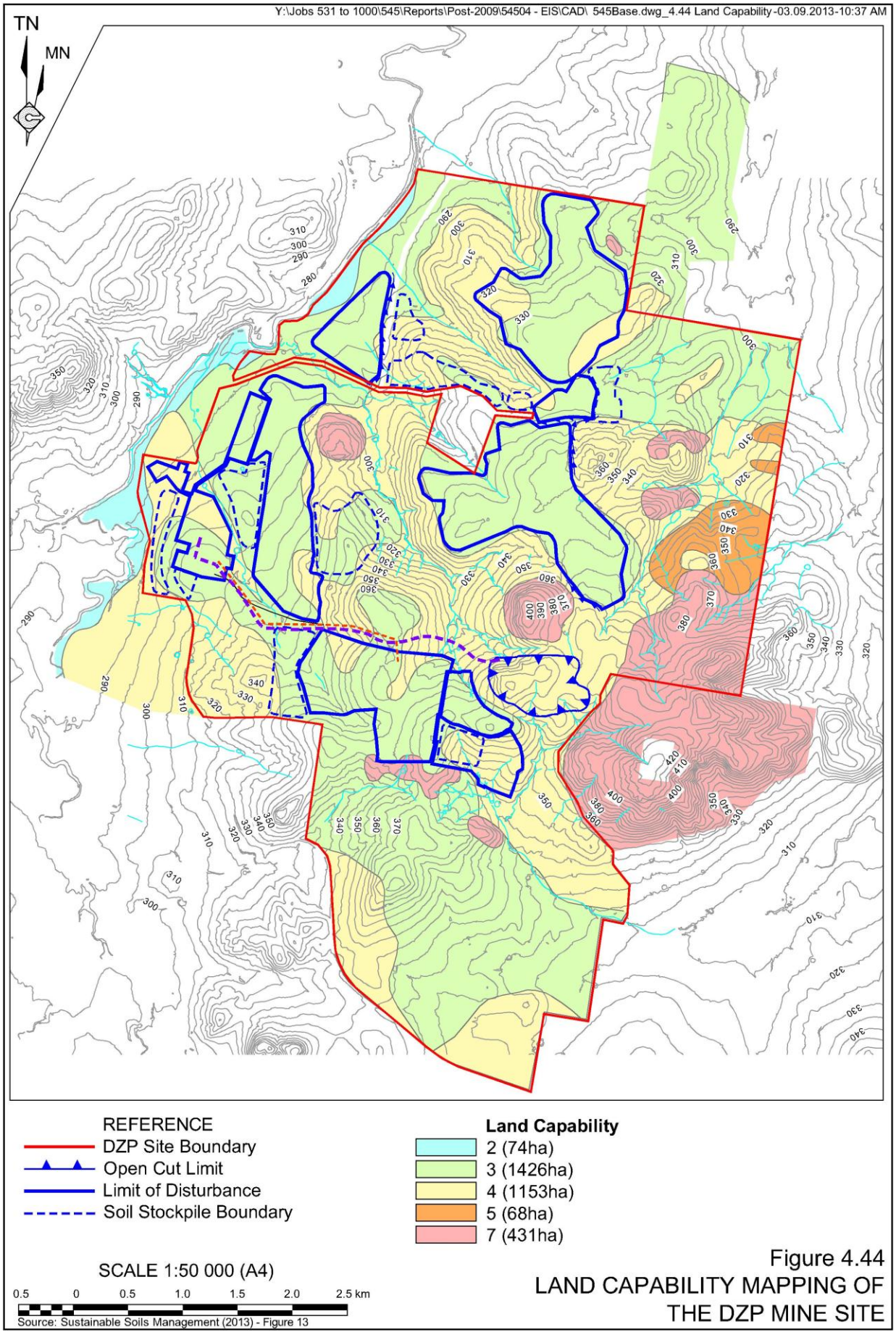

Figure 4.44
LAND CAPABILITY MAPPING OF THE DZP MINE SITE

4.11.3 Management and Mitigation Measures

The Applicant would implement the following soil management and mitigation measures. It is noted that a number of these measures have been identified in Section 2.3.3 and are repeated here for the sake of completeness.

Soil Stripping

- Strip soil material to the depths identified in Section 2.3.3.3 and **Tables 2.1** and **2.2**.
- Ensure that soil material to be stripped is maintained in a slightly moist condition during stripping. Material would not be stripped in either an excessively dry or wet condition.
- Grade or push soil into windrows using graders or dozers for later collection by elevating scrapers or loading into trucks by front-end loaders to minimise compaction of soil materials.
- Use soil materials immediately in areas undergoing progressive rehabilitation, where practicable. Where this is not practicable, place soil transported by truck directly into storage or place soil transported by scrapers in thick "lifts" to minimise compaction.

Soil Stockpiling

- Construct the stockpiles as wind rows within each area, avoiding the construction of a single stockpile covering the entire area.
- Use bulldozers or other equipment to push soil dumped by scrapers into stockpiles (to avoid tracking over previously laid soil by the scraper) whenever possible. If material is deposited directly by scrapers it would be deposited in thick "lifts" to minimise compaction.
- Minimise, as far as practicable, the operation of machinery on soil stockpiles to minimise compaction.
- Ensure that soil stockpiles have a maximum height of 3m for subsoil and 2m for topsoil material.
- Leave the surface of the stockpile with an even but roughened surface to assist in erosion control and seed germination and emergence.
- If long term storage (>3 months) is planned, fertilise and establish an appropriate vegetative cover as soon as possible on all soil stockpiles to be retained for more than 3 months.
- Where practical and when conditions are suitable, allow occasional grazing on the vegetated stockpiles to encourage natural return of organic material, e.g. manure. When grazing livestock on stockpiles, livestock would be removed when the soil is wet enough that stock cause poaching of the soil. Livestock would also be removed when groundcover is less than 60% to encourage survival and growth of the pasture species.

Soil Respreading and Rehabilitation

The aim of soil respreading is to construct a layered material with properties that can perform similar functions to the undisturbed soil. Topsoil provides a path for entry of water and air, storage of nutrients and water, and plant support. The respread subsoil would be dense enough to support plants, but not so dense that it forms a barrier to water movement. Subsoil has a larger role in storage of water than nutrients, and is important in supporting plants. The soil would not have large differences between the properties of layers as the discontinuities at these boundaries can slow water movement. The following management measures for the respreading of soil would provide for the achievement of these aims.

- Test the subsoil to ensure that it is not toxic to plant growth. Major threats are salinity that has built up from adjacent liquid residue storage facilities, and elevated levels of some micronutrients from prolonged reducing (waterlogged) conditions.
- Ensure that subsoil to be worked is moist or dry, but not wet.
- Form sub-grade to desired shape prior to application of subsoil.
- Tyne sub-grade (approximately 60cm deep) to provide an undulating boundary and disrupt barriers to water movement from compaction.
- Place subsoil to achieve similar density (or slightly less) than natural subsoil. This would be achieved by placing subsoil in relatively thick lifts (20 cm) with an elevating scraper and minimising further traffic on areas where material has been placed.
- Lightly tyne the surface between lifts to reduce creation of slowly permeable layers.
- Prior to respreading, the topsoil would be tested to determine the ameliorants required to achieve the desired level of plant growth.
- Tine the surface of underlying subsoil material below the depth of compaction to minimise formation of a dense layer at the top the subsoil / growth material.
- Ensure that topsoil is not respread when either excessively dry or wet.
- Minimise, as far as practicable, the operation of machinery / vehicles on respread topsoil material to minimise compaction.
- Place the soil material with only a few lifts from an elevating scraper or similar with sufficient regrading to create a density similar to natural soil.
- Establish vegetation on topsoiled areas as quickly as possible to minimise the risk of erosion from wind or water.

Sections 2.17.6.3 to 2.17.6.7 provide the general soil stripping, stockpiling and respreading strategies to be implemented by the Applicant for each rehabilitation domain. These strategies are drawn from the recommendations provided by *Section 6.2* of SSM (2013), which follow a review of best practice land management and rehabilitation techniques.

4.11.4 Assessment of Impacts

4.11.4.1 Soils

The topsoil and subsoil inventories presented in **Tables 2.1** and **2.2**, incorporate soils depths recommended by SSM based on the properties of the soils, the specific activity proposed for that area and the required volume of topsoil and subsoil necessary to undertake the soil replacement proposed in Section 2.17.6.9.

The proposed management measures of Section 4.11.3 are based on the recommendations provided by SSM (2013) aimed at maximising the recreation of a soil profile that provides a topsoil layer for the entry and storage of water, air and nutrients for plant support and a subsoil layer for retention of water and deep root penetration.

On the basis that the volume of soil to be stripped would be minimised to that required for rehabilitation, and managed to maximise the potential re-use in the rehabilitation of the disturbed areas of the DZP Site, impacts on the soils of DZP Site are assessed as likely to be effectively mitigated and limited to the life of the Proposal.

4.11.4.2 Land and Soil Capability

The Proposal would have significant effects on the land and soil capability of the DZP Site. At present (pre development) the majority of the land beneath those areas of the DZP Site to be disturbed is Class 3 or Class (**Figure 4.44** and **Table 4.69**) which can support cultivation and high intensity grazing (OEH, 2012). During the life of the Proposal, the majority of the disturbance footprint would be removed from agricultural use and would therefore be rated as Class 8. If the soil stockpiles are sown with pasture immediately after stockpiling and used for rotational grazing, these areas would provide Class 4 land over the life of the Proposal.

The land and soil capability of the rehabilitated landform would be determined by properties of the reconstructed land slope for areas subjected to the greatest disturbance. The final capability of areas disrupted less would be determined by both the extent of disturbance and properties of the underlying landscape. Based on the proposed final landform and implementation of the noted management and mitigation measures, SSM (2013) considers the final landform land and soil capabilities of the DZP Site to be as presented in **Table 4.71**.

Some further reduction in higher capability class land would occur as a result of the development of the proposed BOA (refer to Section 2.17.8). Based on the proposed areas to be incorporated into the BOA (see Section 2.17.8 and **Figure 2.23**), approximately 190.4ha of Class 3 land and 400.8ha of Class 4/5 land would be reduced to Class 6 (for occasional grazing but no cultivation). The area of higher land and soil capability has been included within the BOA for two reasons.

1. These areas represent (predominantly) derived native grassland of an Endangered Ecological Community (EEC). As such, significant benefit to local biodiversity would be provided by returning this land to its original vegetation community type.
2. The area provides for a habitat corridor between two native vegetation remnants within the local setting, Dowds Hill and Wambangalang Creek. Again this would provide a significant benefit to local biodiversity values.

Noting the relatively low productivity of this land currently (refer to *Section 5.3* the AIS – **Appendix 9**) and significant biodiversity benefits to be achieved by the proposed BOA in its current form, the removal of this area of Class 3 land is reasonable.

Table 4.71
Land and Soil Capability Class of the Rehabilitated Final Landform

Infrastructure Type	2	3	4	6	7	8	Total
Open Cut	0	0	0	0	0	40.3	40.3
Waste Rock Emplacement	0	0	0	20.4	0	0	20.4
Solid Residue Storage Facility	0	0	0	102.8	0	0	102.8
Liquid Residue Storage Facility	0	0	425.4	0	0	0	425.4
Salt Encapsulation Cells	0	0	0	0	34.6	0	34.6
Haul Road	0	2.9	4.4	0	0	0	7.3
ROM Pad	0	4.2	0	0	0	0	4.2
Processing Plant	0	26.5	16.8	0	0	0	43.3
Soil Stockpiles	0	88.4	41.0	0	0	0	129.4
Total	**0**	**122.0**	**487.6**	**123.2**	**34.6**	**40.3**	**807.7**

Source: Modified after SSM (2013) – Table 29

There would be an overall reduction in the area of Class 3 land, however, as the majority of this would be rehabilitated to Class 4 land, there would be no major reduction in overall land capability. Those areas of the DZP Site to remain undisturbed by the Proposal would retain the same pre-Proposal land capability (unless incorporated into the proposed Biodiversity Offset Area). **Table 4.72** provides a summary of the land capability of those areas of the DZP to be disturbed or modified prior to, during and following the operation and rehabilitation of the DZP.

Table 4.72
Range of Land and Soil Capability Classes over the Life of the Proposal

Infrastructure Type	Current	During Mine Operation	Post Rehabilitation
Open Cut	4	8	8
Waste Rock Emplacement	3, 4	8	6
Solid Residue Storage Facility	3, 4, 7	8	6
Liquid Residue Storage Facility	3, 4	8	4
Salt Encapsulation Cells	3, 4, 7	8	7
Haul Road	3, 4	8	3, 4
ROM Pad	3	8	3
Processing Plant	3, 4	8	3, 4
Soil Stockpiles	2, 3, 4, 7	4	2, 3, 4, 7
Biodiversity Offset Area	3, 4, 7	6, 7	6, 7

Source: Modified after SSM (2013) – Table 27

4.11.4.3 Agricultural Suitability

The reduction in soil and land capability resultant from the proposed activities of the Proposal and establishment of a Biodiversity Offset Area are likely to restrict the range of agricultural enterprises that the land would support beyond the life of the Proposal. Overall, therefore the agricultural suitability of the DZP Site would be reduced. SSM (2013) provides a summary of the likely post-Proposal suitability of the DZP Site to agricultural activities. A more detailed analysis of current and future agricultural productivity of the DZP Site is provided in an Agricultural Impact Statement prepared by RWC and Diana Gibbs & Associates Pty Ltd and provided as **Appendix 9** of the EIS.

4.12 TRAFFIC AND TRANSPORTATION

4.12.1 Introduction

The Director-General's Requirements (DGRs) issued by DP&I identified "*Traffic and Transport*" as a key issue requiring that the "*EIS provide:*

- *accurate predictions of the road and rail traffic generated by the proposal;*
- *an assessment of the capacity of the rail network to accommodate the transport of ore;*
- *an assessment of the potential traffic impacts on the safety and efficiency of the road network; and*
- *a detailed description of the measures that would be implemented to maintain and/or improve the capacity, efficiency and safety of the road and rail networks in the surrounding area over the life of the proposal.*"

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Roads & Maritime Services (RMS) which requested that a "*traffic study is to be undertaken which includes, but is not limited to origin-destination of vehicles, including staff, contractors, construction, and maintenance personnel during both the construction and operation phases of the development*". Also appended to the DGRs is correspondence from Dubbo City Council that requested detailed information and assessment primarily related to the impact of the proposed rail line reopening on local traffic and proposed upgrades to local road infrastructure to cater for the proposed increase in traffic.

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to traffic and transport and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Temporary inconvenience to commuters if stopped for road works and loss of productivity (medium to high).
- Elevated risk of accident/incident on local roads (high).
- Hydrocarbon or other pollutant contamination of surface water from chemical spill or heavy vehicle movements (medium to high).

- Chemical spills from road or rail accidents causing a broad dispersion of chemicals (medium to high).
- Loss of life/property damage through collision with train (high).
- Increased traffic creating pressure on existing road and infrastructure function (high).
- Accelerated road pavement deterioration (very high).
- Contamination of local water resources by leaking or spilt chemical reagent (medium).

The traffic impact assessment for the Proposal was undertaken by Mr Ben Rossiter of Constructive Solutions Pty Ltd. The resulting report is presented as Part 11 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as "Constructive Solutions (2013)". This subsection of the EIS provides a summary of the traffic impact assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**.

4.12.2 Existing Environment

4.12.2.1 Introduction

The following provides an overview of local road conditions, intersections, railway level crossings, traffic volumes and crash data sufficient to enable an appreciation of local conditions and to provide context to the impact assessment.

4.12.2.2 Local Roads

The following describes the roads proposed for use by Proposal-generated traffic, namely, Toongi Road, Obley Road (between the Newell Highway and Toongi Road), Boothenba Road and Yarrandale Road (see **Figure 4.45**). The information presented is based on the inspections undertaken by Mr Doug Seymour and Mr Ben Rossiter of Constructive Solutions in February 2012 (Obley Road and Toongi Road) and March 2013 (Boothenba Road and Yarrandale Road). Additional information on the pavement condition of Obley Road is based on Falling Weight Deflectometer (FWD) testing completed along Obley Road in 2012 by GR Webb Consulting Pty Ltd.

Toongi Road

Toongi Road is a two-lane, two-way road with a central 4.5m sealed carriageway at the intersection with Obley Road (see **Plate 4.1**), narrowing to 3.0m to 3.5m after The Springs Road intersection (see **Plate 4.2**). Toongi Road is a no-through road which services several rural properties along its length and ends after crossing the Dubbo-Molong Rail Line approximately 1.6km from Obley Road. The alignment is good with the exception of two right angle bends which have no warning or speed advisory signage.

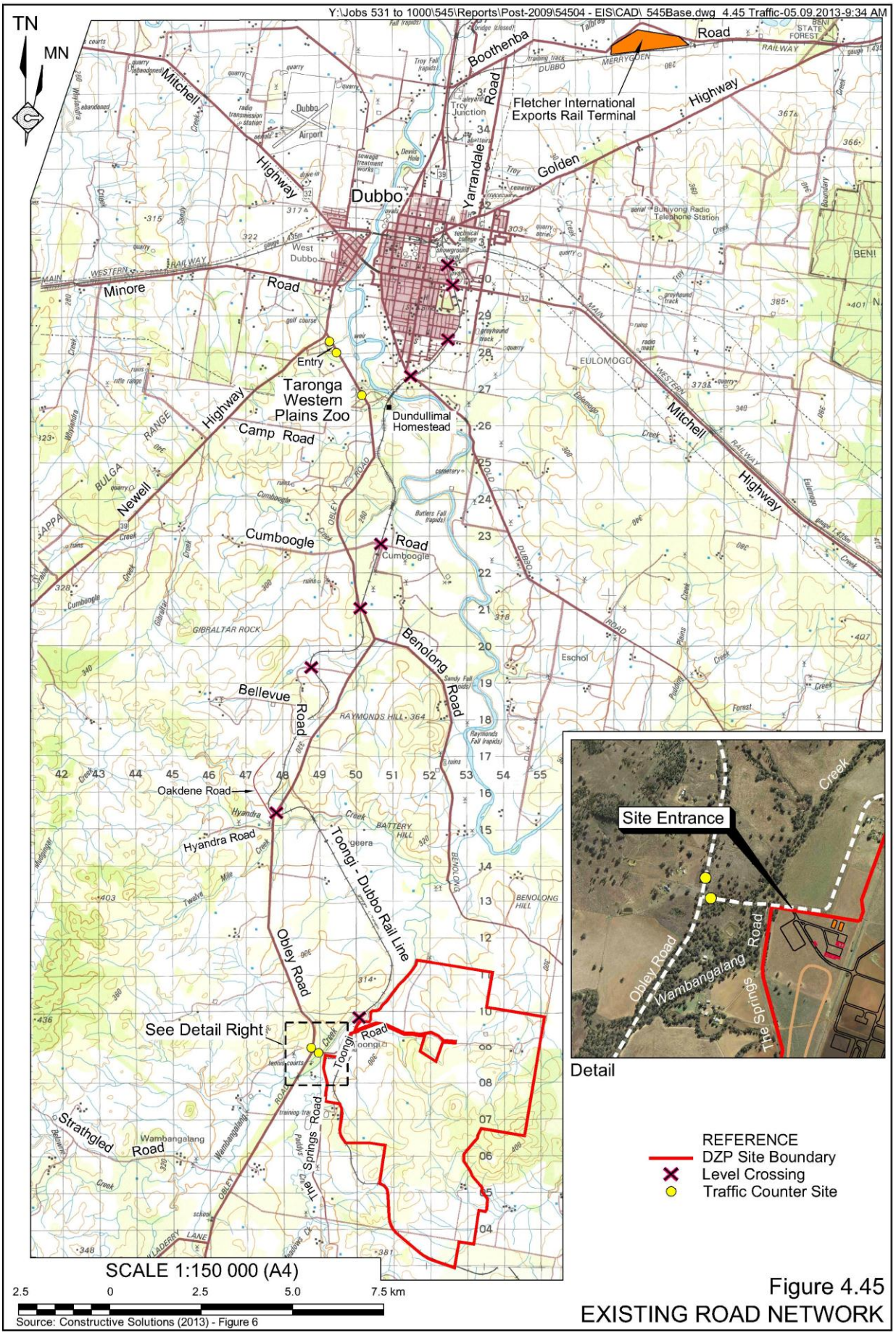

Figure 4.45
EXISTING ROAD NETWORK

Plate 4.1: Toongi Road from the Obley Road Intersection
(Ref: Constructive Solutions 2013 - Plate 27)

Plate 4.2: Toongi Road Alignment and Condition (beyond The Springs Road Intersection)
(Ref: Constructive Solutions 2013 - Plate 4)

Plate 4.3: Causeway crossing of Wambangalang Creek
(Ref: Constructive Solutions 2013 - Plate 5)

Plate 4.4: Obley Road Typical Alignment and Condition
(Ref: Constructive Solutions 2013 - Plate 1)

Toongi Road crosses Wambangalang Creek on a causeway with six 1 050mm reinforced concrete low flow pipes (see **Plate 4.3**) approximately 260m from the intersection of Obley Road. Toongi Road forms a T-intersection with The Springs Road a further 85m from Wambangalang Creek and forms the first of two right angle bends approximately 280m beyond The Springs Road.

Dubbo City Council is the authority responsible for Toongi Road.

Obley Road

Obley Road, which is aligned between the Newell Highway south of Dubbo and the Mitchell Highway at Molong, is a two-lane, two-way road with a central sealed carriageway varying in width (see **Plate 4.4**). Obley Road primarily services the existing properties along its length, however, it is also used as an alternative route to Dubbo from the south for vehicles choosing to avoid the Mitchell Highway.

There are three major creek crossings on Obley Road.

- Hyandra Creek: a 12m span, timber bridge providing a low flow crossing. Flood modelling completed by SEEC (2013) indicates that the elevation of the bridge is below the 1 in 5 ARI flood event.
- Cumboogle Creek: a concrete bridge structure with 7m pavement (corresponding to the width of the bridge) elevated above the local floodplain. The bridge deck is well above the channel below.
- Twelve Mile Creek: a single 450mm reinforced concrete pipe low flow causeway. Flood modelling completed by SEEC (2013) indicates that the elevation of the causeway and the road for several hundred metres in either direction is below the 1 in 5 ARI flood event.

There are several existing intersections, and one proposed new intersection (to Taronga Western Plains Zoo opposite the Dundullimal Homestead), between the Newell Highway and the DZP Site, namely:

- Taronga Western Plains Zoo (existing);
- Hyandra Road;
- Oakdene Road;
- Bellevue Road;
- Benolong Road;
- Cumboogle Road;
- Belowrie Road;
- Camp Road; and
- Toongi Road.

The first 9.5km of Obley Road from the Newell Highway towards Toongi Road is relatively flat with good horizontal and vertical alignment. The seal width is approximately 9m and is in good condition although general pavement deformation was evident at the time of inspection. From 9.5km to 19.9km, no centre lines are marked and the seal narrows with pavement in average condition. From 19.9km to Toongi Road, line marking returns and the seal widens again. In certain sections the alignment is sub-standard for the sign-posted speed of 100km/hr.

The age, quality and depth of the existing pavement were found to vary significantly and **Table 4.73** summarises the existing pavement conditions.

Table 4.73
Existing Pavement – Obley Road

Characteristic	Maximum	Minimum
Pavement Thickness (mm)	440	110
Subgrade CBR* (%)	43.6	3.7
Source: Modified after Constructive Solutions (2013) – Table 4 *CBR = California Bearing Ratio (a measure of mechanical strength)		

Falling weight deflectometer (FWD) results were also completed to assist in determining the suitability of the existing pavement with deflections up to 2.3mm evident. The deflection in the pavement, combined with the CBR results, were utilised to determine suitable pavement designs.

Obley Road forms part of the Western Plains Tourist Circuit, is currently used by cyclists (including for annual events) and there is a shared pedestrian / cycle way from the Newell Highway to Taronga Western Plains Zoo. There are known school bus stops adjacent to the intersections with Camp Road and Oakdene Road and two at properties between them. At least another two stops are located between Oakdene Road and Strathgled Road (approximately 3.8km south of Toongi Road – see **Figure 4.45**). As is common on rural school bus routes, stop locations are likely to change over time as younger children begin school and older children finish.

Obley Road is currently designated as a State B-Double route from the Newell Highway to Benolong Road (a distance of 9.3km) according to the RMS Restricted Access Vehicle (RAV) maps. It is noted, however, that Obley Road is a local road and therefore Dubbo City Council is the relevant authority for road maintenance and authorising multi-combination vehicle access.

Boothenba Road

Boothenba Road is a two-way, two-lane undivided sealed local road on the northern periphery of the Dubbo urban area that links the Newell Highway to Yarrandale Road. It has line-marking for only a short distance east of the Newell Highway. The alignment is generally straight and flat. The road has wide unsealed shoulders suitable for heavy vehicles to pull off.

One school bus service is known to operate in the morning westbound along Boothenba Road to Yarrandale Road (and therefore not on the subject length of road). In the afternoon, it only uses Boothenba Road to return empty to the depot.

Yarrandale Road

Yarrandale Road is a two-way, two-lane undivided sealed local road on the northern periphery of the Dubbo urban area. It terminates at Boothenba Road at the north and links it to the access to the Fletcher International Exports rail terminal. It is consistently line marked along the section to be incorporated into the proposed transport route and has 1m wide sealed shoulders south of the railway crossing which is located approximately 150m south of Boothenba Road.

One school bus service is known to operate in the morning southbound along Yarrandale Road from Boothenba Road to Purvis Lane, however, there are no known school bus stops along Yarrandale Road.

4.12.2.3 Intersections

4.12.2.3.1 Newell Highway to the DZP Site

Newell Highway and Obley Road

Obley Road approaches the Newell Highway at an acute angle, however, the intersection is dimensionally adequate for 26m B-Doubles. The Newell Highway includes a channelised right turn (CHR) and an auxiliary left turn treatment (AUL) for movements into Obley Road. Give way controls include a give way sign and a hold line on Obley Road. A sight screen is been located opposite the T-junction and there is no street lighting. Both the Newell Highway and Obley Road are signposted at 80km/hr at the intersection.

Sight distance is estimated to exceed 500m to the north and to be approximately 310m to the southwest (see **Plates 4.5** and **4.6**). These are greater than the minimum desirable sight distance of 126m at 80km/hr calculated in accordance with the Austroads Safe Intersection Sight Distance (SSID).

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Plate 4.5: Newell Highway - Obley Road Intersection (Looking South)
(Ref: Constructive Solutions 2013 - Plate 7)

Plate 4.6: Newell Highway - Obley Road Intersection (Looking North)
(Ref: Constructive Solutions 2013 - Plate 8)

Obley Road and the Entrance to Taronga Western Plains Zoo

The access road to Taronga Western Plains Zoo forms a T-junction with Obley Road. Obley Road has been widened at this intersection to include a Channelised Right Turn (CHR). Give way controls consist of a give way sign and a holding line on the Zoo access road. Obley Road is signposted at 80km/hr at this location. There is no street lighting at the intersection.

Sight distance exceeds 500m in both directions which exceeds the minimum desirable sight distance of 126m at 80km/hr.

Obley Road and Dundullimal Homestead

The driveway to the homestead (receiving an average of 223 visitors per week) is unsealed, however, the mouth of the intersection is sealed. There are no give way controls and no sight screen opposite the T-Junction. There is no street lighting at the intersection. Obley Road is signposted at 100km/hr at this location. Constructive Solutions (2013) report that sight distance is good in both directions.

In 2013 Taronga Western Plains Zoo constructed an entrance to the Zoofari Lodge (overnight accommodation), intersecting with Obley Road directly opposite the Dundullimal Homestead access road. This intersection comprises a Basic Right Turn (BAR) and Auxiliary Left Turn (AUL) and includes modifications to the Obley Road alignment to improve the available sight distance. There are no associated improvements to the Dundullimal Homestead intersection.

Obley Road and Camp Road

Camp Road is a through road which links Obley Road and the Newell Hwy and also forms part of the 'Western Plains Tourist Circuit'. A T-junction joins Camp Road with Obley Road and is basic in configuration. Give way controls consist of a hold line but no give way sign. A sightscreen is located opposite the intersection. Obley Road is signposted at 100km/hr at this location.

Sight distance is good in both directions. To the north, it is 500m and to the south 290m, with both distances greatly exceeding the minimum desirable sight distance of 179m at 100km/hr.

Obley Road and Belowrie Road

Belowrie Road forms a T-junction with Obley Road, providing access to the Morris Park Raceway, and is basic in configuration. There are no give way controls. A small sightscreen is located opposite the intersection. Obley Road is signposted at 100km/hr at this location.

Sight distance is good to the north at 500m but only 140m to the south on Obley Road, which is less than the minimum desirable sight distance of 179m at 100km/hr, due to the horizontal and vertical alignment.

Obley Road, Cumboogle Road and Belmont Road

Cumboogle and Belmont Roads form a cross intersection with Obley Road. Both Cumboogle and Belmont Roads are no-through roads that provide access to various rural properties along their length. Give way controls consist of give way signs on both minor roads but no holding lines are present. Obley Road is signposted at 100km/hr at this location.

Sight distance is good in both directions at 500m to the north and south exceeding the minimum desirable sight distance of 179m at 100km/hr. A school bus stop and shelter is located immediately south of the intersection on the western side of Obley Road.

Obley Road and Benolong Road

Benolong Road forms a T-junction with Obley Road on the outside of a curve. Benolong Road is a through road that provides access to various rural properties along its length. An Auxiliary Right Turn (AUR) and an AUL have been constructed on Obley Road at the intersection. Give way controls consist of a give way sign and hold line. A sightscreen is located opposite the intersection. Obley Road is signposted at 100km/hr at this location.

Sight distance is good in both directions, at 190m to the south and 280m to the north, therefore exceeding the minimum desirable sight distance of 179m at 100km/hr.

Obley Road and Bellevue Road

Bellevue Road forms a T-junction with Obley Road and is basic in configuration. The road provides access to a rural property. There are no give way controls, no sight screen, and the mouth of the intersection is unsealed. Obley Road is signposted at 100km/hr at this location.

Sight distance is good in both directions, at 240m to the south and 300m to the north exceeding the minimum desirable sight distance of 179m at 100km/hr.

Obley Road and Oakdene Road

Oakdene Road forms a T-junction with Obley Road and is basic in configuration. It is a no-through road that provides access to various rural properties. There are no give way controls and no sight screen at the intersection. Obley Road is signposted at 100km/hr at this location.

Sight distance is good to the south at 500m, exceeding the minimum desirable sight distance of 179m at 100km/hr. However, sight distance to the north is limited to 110m due to the horizontal and vertical alignment at the nearby rail crossing.

Obley Road and Hyandra Road

Hyandra Road forms a T-junction with Obley Road and is basic in configuration. Hyandra Road provides access to a rural property. There are no give way controls, no sight screen, and the mouth of the intersection is unsealed. Obley Road is signposted at 100km/hr at this location.

Sight distance is good in both directions, being 500m to the south and 300m to the north, therefore exceeding the minimum desirable sight distance of 179m at 100km/hr.

Obley Road and Toongi Road

Toongi Road forms a T-junction with Obley Road and is basic in configuration. The shoulders on Obley Road have been widened to form a basic right turn (BAR) and a basic left turn (BAL). Give way controls consist of a hold line but no give way sign. A sightscreen is located opposite Toongi Road but it has been set low. Obley Road is signposted at 100km/hr at this location. The geometry of the intersection is adequate for B-Double movements, and the pavement is in good condition.

Sight distance is reasonable to the north at 240m and average to the south at 220m due to the horizontal and vertical alignment. Therefore, sight distance in both directions exceeds the minimum desirable sight distance of 179m at 100km/hr (see **Plates 4.7** and **4.8**).

Toongi Road and The Springs Road

The Springs Road forms a T-junction with Toongi Road approximately 70m east of the Wambangalang Creek causeway and is basic in configuration. There are no give way controls. A small sight screen is positioned opposite The Springs Road approach.

The existing sight distance to the west is estimated to be less than 50m due to the proximity of the Wambangalang Creek crossing.

4.12.2.3.2 Fletcher International Exports Rail Terminal to the Newell Highway

Fletcher International Exports and Yarrandale Road

The access to the Fletcher International Exports rail terminal meets Yarrandale Road approximately 950m south of Boothenba Road. It is approximately 50m south of the railway level crossing on Yarrandale Road.

A concrete median is located in the access roadway where it meets Yarrandale Road but without give way controls (see **Plate 4.9**).

Boothenba Road and Yarrandale Road

Yarrandale Road forms a T-intersection with Boothenba Road approximately 1.9km east of the Newell Highway (see **Plate 4.10**). Traffic controls consist of a give way sign and holding line on Yarrandale Road. There are no turning lanes for traffic either entering or exiting Yarrandale Road. The geometry of the intersection is adequate for B-Doubles to turn left or right in to or out of Yarrandale Road.

Sight distance at the intersection is good in both directions at 340m to the west and 300m to the east, therefore exceeding the minimum desirable sight distance of 126m at 80km/hr.

Newell Highway and Boothenba Road

Boothenba Road is the eastern leg of a cross-intersection with the Newell Highway, with the western leg opposite Boothenba Road known as Troy Bridge Road. The intersection includes a channelised right turn (CHR) and an auxiliary left turn treatment (AUL) for movements into Boothenba Road. Give way controls include a give way sign and holding line on Boothenba Road. Lighting is provided along the Newell Highway on both approaches.

There is an active railway level crossing located on Boothenba Road approximately 35m east of the give way holding line at the Newell Highway. Dubbo City Council has secured State funding to realign the railway line so it crosses Boothenba Road further to the east. This would increase the total queue length to approximately 150m from the Newell Highway to the relocated level crossing. This would provide for up to three B-Triple (road train) heavy vehicles to queue westbound on Boothenba Road without any encroachment onto the Newell Highway.

Plate 4.7: Obley Road - Toongi Road Intersection (Looking South)
(Ref: Constructive Solutions 2013 - Plate 25)

Plate 4.8: Obley Road - Toongi Road Intersection (Looking North)
(Ref: Constructive Solutions 2013 - Plate 26)

Plate 4.9: Fletcher International Rail Terminal Access - Yarrandale Road Intersection
(Ref: Constructive Solutions 2013 - Plate 28)

Plate 4.10: Looking South along Yarrandale Road from the Intersection with Boothenba Road
(Ref: Constructive Solutions 2013 - Plate 29)

The available sight distances to the south and north are estimated to be greater than 500m in each direction which exceeds the minimum desirable sight distance of 151m at 90km/hr (see **Plates 4.11** and **4.12)**.

Plate 4.11: Newell Highway - Boothenba Road Intersection (Looking South)
(Ref: Constructive Solutions 2013 - Plate 30)

Plate 4.12: Newell Highway - Boothenba Road Intersection (Looking North)
(Ref: Constructive Solutions 2013 - Plate 31)

4.12.2.4 Railway Level Crossings

The re-opening of the Toongi-Dubbo Rail Line would require the re-opening of four level crossings within the Dubbo urban area and five level crossings between Dubbo and Toongi. The rail line consists of one track at all locations.

Plates 4.13 to **4.21** depict the following nine railway level crossings to be re-opened. Each of these is identified on **Figure 4.45**.

Dubbo City Limits

- Wingewarra Street (**Plate 4.13**).
- The Mitchell Highway (**Plate 4.14**).
- Boundary Street (**Plate 4.15**).
- Macquarie Street (Old Dubbo Road) (**Plate 4.16**).

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Plate 4.13: Looking East on Wingewarra Street from the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 32)

Plate 4.14: Looking West on Cobra Street from the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 33)

Plate 4.15: Looking West on Boundary Street from the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 34)

Plate 4.16: Looking West on Macquarie Street from the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 35)

Dubbo to Toongi

- Obley Road (Crossing 1) (**Plate 4.17**).
- Obley Road (Crossing 2) (**Plate 4.18**).
- Cumboogle Road (**Plate 4.19**).
- Bellevue Road (**Plate 4.20**).
- Toongi Road (**Plate 4.21**).

The rail line also crosses numerous rural property driveways and farm tracks along its length.

4.12.2.5 Traffic Levels

Existing traffic levels were established by examining and analysing the following.

- Historic traffic count data published by the RTA (now RMS).
- Data collected from four specifically placed traffic counters on Obley Road and one on Toongi Road at the locations identified on **Figure 4.45**.
- Manual intersection traffic counts.

Table 4.74 summarises the traffic data available for the Newell Highway and estimates traffic volumes for 2016 and 2036 assuming a growth factor of 1.5% per annum as recommended by Dubbo City Council.

Table 4.74
Traffic Volumes (Newell Highway)

Station No.	Road (Location)	1992 AADT	1996 AADT	1999 AADT	2002 AADT	2005 AADT	2016 AADT (est.)	2036 AADT (est.)
93.046	Newell Hwy, SH17 - 1.5km south of Victoria St (Mitchell Hwy, SH7), Dubbo	5 928	6 443	6 774	6 863	5 153	6 070	8 175
93.61	Whylandra St, (Newell Hwy, SH17) - south of Victoria St (Mitchell Hwy, SH7), Dubbo		16 257	17 550	18 448	18 363	21 631	29 133
93.861	Newell Hwy SH17 - 13 Mile Ck, Narromine/Dubbo Boundary	3 103	3 715	4 044	4 314	4 304	5 070	6 828

Source: RMS, 2005 (modified after Constructive Solutions 2013 – Table 6)
AADT = Annual Average Daily Traffic

Table 4.75 summarises the traffic data obtained from the placement of traffic counters on Obley Road and Toongi Road, and made available by Dubbo City Council for Boothenba Road and Yarrandale Road, along with estimates of 2036 traffic volumes (assuming a growth factor of 1.5% per annum).

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Plate 4.17: Looking North on Obley Road from Rail Crossing 1
(Ref: Constructive Solutions 2013 - Plate 36)

Plate 4.18: Looking South on Obley Road from Rail Crossing 2
(Ref: Constructive Solutions 2013 - Plate 37)

Plate 4.19: Looking East on Cumboogle Road at the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 38)

Plate 4.20: Looking West on Bellevue Road at the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 39)

Plate 4.21: Looking East on Toongi Road at the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 40)

Table 4.75
Current and Forecast Traffic Volumes: Obley Road, Toongi Road, Boothenba Road and Yarrandale Road

Site	Year	AADT	Heavy Vehicles %	Max peak/hr vehicles	AADT 2036 (est.)	AADT 2036 HV (est.)
Obley Road (between Newell Hwy & Zoo entry)	2012	2 330	10.9	332	3 331	363
Obley Road, 100m East of Zoo entry	2012	1 257	11.2	166	1 797	201
Obley Road (250m north of Dundullimal Homestead)	2012	1 201	18.0	178	1 717	309
Obley Road (100m north of Toongi Road)	2011	390	21.0	47	566	119
	2012	388	38.0	51	555	211
Toongi Road (Immediately east of Obley Road)	2011	105	23.0	18	152	35
	2012	91	17.0	16	130	22
Boothenba Road (East of Yarrandale Road)	2001	750	24.1	NA	-	-
	2016 equivalent	938	24.1	NA	1 263	304
Boothenba Road (50m west of Saleyards entry)	2002	1 436	20.7	NA	-	-
	2016 equivalent	1 768	20.7	NA	2 382	493
Yarrandale Road (200m north of Purvis Lane)	2010	2 701	39.3	NA	-	-
	2016 equivalent	2 953	39.3	NA	3 978	1 563

Source: Modified after Constructive Solutions 2013 – Tables 7 and 8
AADT = Annual Average Daily Traffic

Table 4.76 summarises the traffic data made available by Dubbo City Council at the locations of the disused railway crossings within Dubbo, along with estimates of 2036 traffic volumes (assuming a growth factor of 1.5% per annum).

Table 4.76
Traffic Volumes at Rail Crossings

Road	Location	Year of Data	Average Total Daily Volume	Max peak vehicles/hr	AADT 2036 (Est)
Wingewarra Street	Between Chelmsford & Kokoda St	2008	9 703	1 173	-
		2016 equivalent	10 930	1 245	14 722
Mitchell Highway (Cobra Street)	Near Apex Oval	2011	19 575	2 052	-
		2016 equivalent	21 088	2 083	28 402
Boundary Street	West of Wheeler's Lane	2007	3 146	341	-
		2016 equivalent	3 597	367	4 845
Macquarie Street (Old Dubbo Road)	North of Margaret Cres intersection	2010	1 386	164	-
		2016 equivalent	1 516	169	2 041
Source: DCC (modified after Constructive Solutions (2013) – Table 9)					

4.12.2.6 Accident Statistics

Detailed crash reports were obtained from NSW Transport Centre for Road Safety. The data obtained summarised crashes on the subject roads between 1 January 2007 and 30 June 2011. A summary of the data is provided in **Table 4.77**.

Table 4.77
Crash Data 2007 - 2011

Road	Extent		Fatal	Injury	Non Casualty
Obley Road	Newell Highway	Toongi Road	0	6	8
Toongi Road	Toongi Road	The Springs Road	0	0	0
Boothenba Road	Newell Highway	Yarrandale Road	0	5	6
Yarrandale Road	Boothenba Road	Fletcher International Exports Access	0	0	0
Source: Constructive Solutions (2013) – Table 14					

Obley Road

Fourteen crashes were recorded on Obley Road between the Newell Highway and Toongi Road. Eleven were single-vehicle accidents and three were collisions between two vehicles. Thirteen were cars, three were light trucks and one a single motorcycle. No heavy vehicles over 4.5t GVM featured in the crash profile.

Non-road environment factors contributed significantly to Obley Road crashes, with five featuring speeding, four fatigue and two alcohol. Avoiding an animal contributed to two crashes, one struck an animal, whilst a driver disobeying a traffic control contributed to another crash. Loose gravel on road shoulders contributed to three crashes.

No clusters of multiple crashes at one location were identified, other than two separated by 50m just north of Oakdene Road. Constructive Solutions (2013) considers that this appears coincidental rather than related to the road environment of the location. One crash involved a motorcyclist leaving the carriageway to the left of a right-hand curve, with loose gravel identified as a hazardous factor, whilst the other involved a car leaving a straight length of road.

Obley Road – Newell Highway Intersection

One crash occurred when a northbound vehicle turning right into Obley Road colliding with a southbound vehicle on the Newell Highway. Alcohol was identified as a contributing factor.

Boothenba Road

Eleven crashes were recorded on Boothenba Road. Four were single-vehicle accidents and seven were collisions between two vehicles. Eleven vehicles were cars, six were light trucks and one was a heavy vehicle over 4.5t GVM (semi-trailer). Two crashes on Boothenba Road involved fatigue, one speeding and one alcohol. Another involved a driver disobeying a traffic control.

Two clusters of multiple crashes were identified on Boothenba Road, namely the intersections with the Newell Highway and Yarrandale Road.

Boothenba Road – Newell Highway Intersection

All three crashes at this cross-intersection were cross traffic, right-angle two-vehicle collisions. There were two injury crashes resulting in three injuries and one non-injury crash. Four of the vehicles involved were cars, the other two were light trucks. No speeding, fatigue or alcohol contributed to any of the collisions although two had a contributing factor of the driver disobeying the Give Way traffic control.

Boothenba Road – Yarrandale Road Intersection

Two crashes at this T-intersection featured single northbound vehicles running off the end of Yarrandale Road where it terminates at Boothenba Road. One of these accidents involved driver fatigue. Both resulted in no injuries. A third crash at this location involved a semi-trailer eastbound on Boothenba Road turning right into Yarrandale Road, colliding with a car, resulting in seven injuries.

4.12.3 Changes to Traffic Levels Resultant from the Proposal

4.12.3.1 Construction Traffic

As discussed in Section 2.12, the construction phase of the Proposal would occur over a period of approximately 18 months to 2 years. During this period, a peak workforce of between 300 and 400 employees would be required, of which virtually all would be accommodated in Dubbo.

Heavy vehicle deliveries of construction materials and equipment are expected on a daily basis including occasional oversize vehicles.

Constructive Solutions (2013) has assumed the following range of vehicle movements per day (where 1 return trip generates 2 movements) during construction in order to account for the variability in generated traffic volumes generally experienced during construction activities.

- Light Vehicle Movements: 300 – 400
- Heavy Vehicle Movements: 5 – 60

It is noted that traffic levels generated during the construction phase of the Proposal would be equivalent to levels generated during operations (although with a greater proportion of light vehicle movements). On the basis of the similar traffic levels, operational traffic levels (see Section 4.12.3.2) have been utilised for assessment purposes.

4.12.3.2 Operational Traffic

Heavy Vehicles

As discussed in Section 2.12, three options are being considered for the transportation of reagents to, and despatch of products from, the DZP Site. The estimated daily heavy vehicle movements on local roads within the proposed transport route for each option is outlined in **Table 4.78**.

For assessment purposes, the transport option likely to generate the greatest number of heavy vehicles (Option B) has been utilised.

Table 4.78
Worst Case Heavy Vehicle Scenario Based on Reagent Transport Options

	Largest Haulage Vehicle	Option A	Option B	Option C	HV AADT (worst case)
Obley Road	B-double / single	88	158	138	158
Toongi Road	B-double / single	88	158	138	158
Boothenba Road	Single	28	98	0	98
Yarrandale Road	Single	28	98	0	98
Source: Constructive Solutions (2013) – Table 11					

Light Vehicles

Once fully operational, the Proposal would employee up to 250 personnel in operational and management roles. It is anticipated that the majority of employees would reside locally in Dubbo with only a small percentage of the workforce beginning their journey south of Toongi. Using the assumption that the majority of employees would commute to and from the DZP Site in their own vehicle, with the remainder travelling to and from in a car pool arrangement, a maximum of 150 light vehicles per day (300 movements) are anticipated on the route between Dubbo and Toongi. The likely increase in vehicles originating south of Toongi has been considered to be negligible.

A further 10 miscellaneous light vehicles (20 movements) has been assumed on any given day to allow for visitors.

Combined Traffic Generation

The DZP is expected to begin construction in 2014 and operations in 2016. Under the current application, an operational life of 20 years is proposed. The AADT without Proposal-related traffic for 2036 was therefore forecast using a conservative growth factor of 1.5%. The increase in AADT levels due to the Proposal on Obley Road and Toongi Roads is shown in **Table 4.79**.

Table 4.79
Forecast Background and Combined Traffic Volumes

		Forecast Traffic (2036)*		DZP Traffic		Combined Traffic (2036)		Increase	
Road	**Site**	**LV**	**HV**	**LV**	**HV**	**LV**	**HV**	**TOTAL**	**%**
Obley Road	Between Newell Hwy & Zoo Entry	2 968	363	320	158	3 288	531	3 809	14%
	100m North of Toongi Road	344	211	320	158	664	379	1 033	86%
Toongi Road	East of Obley Road	108	22	320	158	428	190	608	368%
Boothenba Road	50m west of Saleyards	1 889	493	0	98	1 889	591	2 480	4%
Yarrandale Road	200m North of Purvis Lane	2 415	1 563	0	98	2 415	1,661	4 076	2.5%

Source: Constructive Solutions (2013) – Table 13

LV = light vehicles HV = heavy vehicles

* Forecast background traffic is based on the most recent counts available (see **Table 4.74**)

4.12.4 Mitigation and Management Measures

General Measures

The following general management and mitigation measures as recommended by Constructive Solutions (2013) would be implemented to ensure the impacts of both construction and operational traffic are acceptable.

- Preparation and implementation of a *Construction Traffic Management Plan* which addresses the following.
  - Road and bridgeworks during the construction phase and potential impacts for existing road traffic and for vehicles accessing the DZP Site.
  - Utility upgrades adjacent to or across public roads.
  - Consideration of the respective intersections including temporary speed limits and other controls.
  - Significant deliveries including any oversize and overmass loads and the suitability of the existing road to accommodate them. In particular, consideration of constraints posed by the existing causeway over Wambangalang Creek would be required prior to its upgrade.
  - Traffic interaction at key intersections where there is a marked increase in traffic.
  - Arrangements for employees to have suitable access to and from the DZP Site.
  - Impacts on other road users during the construction phase including the school bus, cyclists and pedestrians.
  - Impacts on the operation of the Zoo.
  - Avoidance of traffic delays during busy periods such as public holidays, Easter and Christmas holidays.
- Construction of all road and intersection upgrades in accordance with Austroads Standards and Council specifications with suitable dimensional capacity to accommodate the anticipated oversized loads.
- Intersection upgrades to provide simplified traffic interaction and provide appropriate warning(s) relating to the increased volume of heavy vehicles.
- Preparation and implementation of a Code of Conduct for contractors / employees travelling to and from the DZP Site. The code would:
  - identify the designated access routes;
  - cover the Applicant's expectations with respect to drivers' behaviour, management of speed and fatigue;
  - require the avoidance (wherever practical) of school bus operating periods;
  - specific driving protocols when avoidance of school bus periods is not practical; and
  - include disciplinary responses in the event of non-compliance with the code.

- Regular discussions with the school bus company(ies) to ensure that information regarding school bus routes, times and pick-up / drop-off locations remains up to date.
- The use of car pooling and buses where practical.
- Communication with organisers of "Zoo to Zoo" road cycling-type annual events to minimise impacts on construction activities, mine operations and the events.
- Education of the workforce through inductions, toolbox talks etc.
- Scheduling of shift changes to avoid peak traffic periods in Dubbo by at least 1 hour.
- Payment of a road maintenance contribution to Dubbo City Council commensurate with traffic volumes generated by the Proposal. Any maintenance contribution would take into consideration the road upgrades that are proposed by the Applicant.

In addition to the general management and mitigation measures, a range of specific road and intersection upgrade works are proposed. These are detailed in Sections 2.2.4 to 2.2.6 whilst a summary of specific considerations for specific roads are provided as follows.

Newell Highway

- Consultation with Council and RMS in relation to moving the 60km/hr speed zone on the Newell Highway to the south of the Obley Road intersection (currently located approximately 1km north).

Obley Road

- Provision of additional school bus stop pullover areas in consultation with the school bus operator(s) and Council.
- Consultation with the relevant cycling groups to provide specific consideration of safety aspects associated with their use of the road, particularly where sight distance is limited.
- Consultation with Council and RMS in relation to moving the 60km/hr speed zone on Obley Road to the south of the Dundullimal Homestead access road.

Toongi Road

- Ensuring that a suitable access point is established for the existing waste transfer station.
- Consultation with the relevant cycling groups to provide specific consideration of safety aspects associated with their use of the road, particularly where sight distance is limited.

- Consideration of intersection design for the DZP Site Entrance from Toongi Road to address the risk posed by complacency of DZP traffic turning in and out of the DZP Site Entrance into Toongi Road (which has very low background traffic).

Boothenba Road

- Reviewing and addressing the lack of controls at private accesses and other roads intersecting with Boothenba Road.
- Ensuring the relocation of the rail crossing is complete prior to haulage. If the relocation has not been completed prior to haulage, specific measures would be determined in consultation with Dubbo City Council and RMS to minimise the risks of queuing onto the Newell Highway.

Rail Crossings

- Where possible, scheduling trains outside the peak traffic periods (8:00am to 9:00am and 3:00pm to 4:00pm) to reduce the impact of traffic delays at rail crossings.

4.12.5 Impact Assessment

4.12.5.1 SIDRA Analysis

Based on the higher volume of background traffic relative to other intersections along the expected access routes to the DZP Site, the Obley Road and Boothenba Road intersections with the Newell Highway are considered to be the key intersections for performance assessment. The performance of these intersections was modelled using the intersection performance simulation software SIDRA. The remaining intersections along the nominated access route were not modelled as the peak traffic at these intersections is significantly less than the corresponding effective capacity and any SIDRA modelling would provide no additional value to the assessment (Constructive Solutions, 2013).

The purpose of the intersection analysis was to determine whether the existing intersections have the capacity to perform satisfactorily at peak times with the additional traffic anticipated during the operational phase of the Proposal.

Manual counts were taken to determine the peak periods of the day and a peak 15 minute period for analysis. The performance of the two intersections, assuming existing and forecast background traffic, is summarised in **Table 4.80**.

The results indicate that the two intersections modelled would still operate far below their capacity, even in Year 2036 with applied traffic growth of 1.5% per annum. The worst level of service[1] is anticipated to be C based on the worst anticipated delay although it should be recognised that the transport of reagents is not significantly exacerbating the situation.

The results clearly indicate that the introduction of traffic by the Proposal, which represents only a relatively minor percentage, would not significantly impact upon the performance of the intersections.

Table 4.80
Modelled Future Traffic Conditions – Peak Operation

Intersection	Scenarios	Peak Flow	DoS*	Delays (Sec)	LoS* (worst)	Queue (m)
Newell Highway and Obley Road	Background Traffic (2036)	905	0.312	15.0	B	10.3
	Background Traffic (2036) + DZP Traffic	939	0.339	15.1	B	11.8
Newell Highway and Boothenba Road	Background Traffic (2036)	1,217	0.500	32.4	C	20.6
	Background Traffic (2036) + DZP Traffic	1,238	0.508	33.8	C	20.8
*DoS = Degree of Saturation *LoS = Level of Service[5]						
Source: Constructive Solutions (2013) – Table 16						

4.12.5.2 Obley Road

The additional traffic that would occur on Obley Road as a result of the Proposal represents a significant increase above existing and forecast background traffic, particularly near Toongi Road (86% increase) where existing traffic volumes are low. The relative increase between the Newell Highway and the Zoo and Dundullimal Homestead is less (14% increase) due to the significant volume of tourist traffic generated by these attractions. Notwithstanding this, the additional traffic would not result in traffic volumes beyond the effective capacity of Obley Road (Constructive Solutions, 2013).

It is noted that the additional traffic would exacerbate issues associated with the current road standard which include sections of poor road geometry, inadequate stormwater drainage and inadequate pavement. However, the Applicant has committed to a range of road upgrades to address these issues (see Section 2.2.5.2 and **Figure 2.4**).

Major road and stormwater drainage upgrades have been discussed with Council and have received in-principle support, however, it is noted that the specific designs and schedule for these works is to be confirmed as part of a planning agreement or similar with Council.

With the implementation of the proposed upgrade measures, the road standard would significantly improve and increase the effective capacity of Obley thereby mitigating the effects of the Proposal on road capacity.

4.12.5.3 Toongi Road

Toongi Road is a low trafficked road and would be upgraded to the same standard as Obley Road to the DZP Site Entrance. Proposed upgrade works are discussed in Section 2.2.5.3 and Section 2.2.6.

With the implementation of the proposed upgrade measures, the road standard would significantly improve and increase the effective capacity of Toongi Road thereby mitigating the effects of the Proposal on road capacity.

[5] Level of Service is a qualitative measure describing operational conditions within a traffic stream and takes into account service measures such as speed and travel time, freedom to manoeuvre, traffic interruptions, safety, comfort and convenience. There are six levels of service, designated A (best – free flow) to F (worst – breakdown in flow) (Austroads, 2005)

4.12.5.4 Newell Highway

Use of the Newell Highway varies significantly between the various reagent transportation options (see Section 2.12.1). Under all options the principal impact would occur at the Obley Road intersection followed by the Boothenba Road intersection. At both intersections, the volume of turning traffic would increase as a result of the Proposal.

Manual counts undertaken by Constructive Solutions (2013) showed a peak period in the morning and afternoon between 8:00am and 9:00am and 3:00pm and 4:00pm respectively. Consequently, the Applicant has committed to schedule shift changes outside these peaks. Therefore it is not anticipated that shift change traffic would affect the performance of either intersection.

Analysis of the intersections using SIDRA demonstrated that the worst case additional traffic generated by the Proposal would have a negligible impact (see Section 4.12.5.1). Furthermore, Constructive Solutions (2013) concludes that the need for an acceleration lane for merging traffic turning right out of Obley Road is not justified and that delays would not be significantly exacerbated by the Proposal.

The Boothenba Road intersection is also of a suitable standard to accommodate the transport of reagents. As discussed in Section 4.12.2.3.2, Dubbo City Council has secured funding to relocate the railway to cross Boothenba Road further east. This would increase the road traffic queuing capacity during train passage to approximately 150m prior to encroachment of queued traffic onto the Newell Highway.

4.12.5.5 Yarrandale Road

If bulk reagent transport Option A or Option B are adopted for the transport of reagents, a short section of Yarrandale Road between the Fletcher International Exports rail terminal and Boothenba Road would be utilised. Yarrandale Road currently has a high volume of heavy vehicle traffic associated with the prevailing land uses it serves.

This section of road is generally considered suitable for the increase in heavy vehicle movements given the road and associated intersections have been constructed to a suitable standard and therefore appear to have reasonable dimensional capacity and associated controls at both the intersection with the rail terminal and Boothenba Road.

The introduction of additional heavy vehicle movements, associated with the transport of reagents is not anticipated to have a significant impact on the capacity of Yarrandale Road or the associated intersections which are proposed for use.

4.12.5.6 Boothenba Road

Boothenba Road is of a reasonable standard and currently caters for a significant number of heavy vehicles accessing the Fletcher International Exports rail terminal and the Dubbo Saleyards. The road is generally straight and is in reasonable condition.

An assessment of the pavement was not undertaken, however, it is considered that the pavement has a reasonable residual life.

There are a number of intersecting accesses and roads which have limited controls and/or advanced warning. The proposed installation of additional controls including give way and/or stop signs and associated hold lines is considered appropriate to improve awareness.

4.12.5.7 Rail Level Crossings

There are seven public road crossings that would require probable treatment as outlined in Section 2.2.4.4. The impact on road traffic as a result of re-instating the level crossings is largely dependent on two parameters, namely the time(s) of day trains travel through the crossings and their likely speed.

Assuming an average train length of 500m and a travel speed of 10km/hr (in town) and a total of 50 seconds for advanced warning and departure time, the delay to traffic at the intersections equates to approximately 4 minutes. As a worst case scenario, Constructive Solutions (2013) have assumed a delay of 5 minutes to calculate the associated queue lengths as shown in **Table 4.81**.

Table 4.81
Predicted Queue Lengths at Rail Crossings

Road	2036 Equiv. Max Peak Vehicles/hr	Vehicles in Each Direction	Max 5 Minute Queue length (Vehicles)
Wingewarra Street	1,411	706	59
The Mitchell Highway (Cobra Street)	2,307	1,153	96
Boundary Street	511	256	21
Macquarie Street (Old Dubbo Road)	200	100	8
Source: Constructive Solutions (2013) – Table 18			

Notably, the maximum delay would only be incurred by the first car to arrive at the level crossing, with cars arriving as the crossing re-opens incurring a much reduced delay (<1 minute). Assuming a consistent flow of traffic on local roads, the average delay for vehicles would be 2.5 minutes.

It has been assessed that an average 2.5 minute delay (maximum 5 minute delay) six times per week is unlikely to have a significant impact on traffic movement within the Dubbo urban area provided the number of movements during peak hour traffic are limited and that trains do not need to be held at the associated rail crossings waiting to obtain access to the main lines.

In the event trains movements do occur during peak hour, it is anticipated approximately 96 and 59 vehicles would queue at the Mitchell Highway and Wingewarra Street crossings respectively. The associated queue lengths would be significant and likely have some impact at the following intersections (during peak hour).

- Chelmsford Street and the Mitchell Highway.
- Chelmsford Street and Wingewarra Street.
- Hakea Place and Wingewarra Street.
- Kokoda Place and Wingewarra Street.
- Strickland Street and Wingewarra Street.